Economic evaluation of 'supplementary' measures for the WFD programs of measures in Latvia

LATVIAN STUDY REPORT

Project „Towards joint management of the transboundary Gauja/Koiva river basin district" (Nr. EU 38839)

Developed by Pakalniete K. and Fedorovica K (AKTiiVS Ltd.[1])

Riga, 2013

[1] AKTiiVS Ltd. – Economic Research and Consultancy for Water and Biodiversity Protection Policies. (kristinepa@apollo.lv)

Contents

List of abbreviations

AGR	Agriculture
CAP	Common Agricultural Policy
CE	Cost-effetiveness
CEA	Cost-effectiveness analysis
FOR	Forestry
GES	Good ecological status
MCA	Multi-criteria analysis
PoM	Programme of measures
RB	River basin
RBD	River basin district
RBMP	River Basin Management Plan
WB	Water body
WFD	Water Framework Directive
WWTP	Wastewater treatment plant

Introduction

The study was conducted as part of the project "Towards joint management of the transboundary Gauja/Koiva river basin district". The project included work on the economic analysis' elements of the WFD river basin management planning with a general aim to coordinate national approaches in Latvia and Estonia for joint RBMP for 2016-2021.

The economic evaluation of measures for the WFD programs of measures (including the cost-effectiveness analysis (CEA) and socioeconomic impacts' analysis) was among the tasks of the project in relation to the economic analysis' elements. The study aimed:

1. to develop methodology for the economic assessment and evaluation of 'supplementary' measures for the WFD programs of measures taking into account experience from the 1st planning cycle and needs for the 2nd cycle;
2. to collect available information and to conduct the economic assessment and evaluation of the measures applying the developed approach;
3. to assess information provision and identify relevant information gaps and
4. to draw conclusions and develop recommendations in light of applicability of the proposed approach for the economic assessment and evaluation of measures for the next WFD planning cycle.

The given report describes results of the work on the tasks above. At first it discusses needs for improving approach for the economic assessment and evaluation of the measures, which were identified based on experience from the 1st planning cycle and discussions with specialists from national institutions involved in the WFD implementation (the section 1). The approach developed to address these needs is described in the section 2. The section 3 provides information about the 'supplementary' measures included in the study. Detailed results from the assessment of the measures applying the proposed approach are presented in the section 4. The results of the evaluation and prioritisation of the measures are provided in the section 5. The report ends with summary on information provision and gaps (in the section 6) and conclusion in light of applicability of the proposed approach and relevant gaps for future work (in the section 7).

Authors of the report are very grateful to the project's expert Loreta Urtane ("L.U. Consulting" Ltd.) for hers valuable contribution in relation to environmental issues of the study and Iveta Teibe (Latvian Ministry of Environment Protection and Regional Development) for hers valuable contribution in relation to policy and institutional issues of the assessment of measures.

1 Needs for improving the approach for economic evaluation of measures for the next WFD planning cycle

The economic evaluation of 'supplementary' measures for the 1st RBMPs in Latvia included the cost-effectiveness analysis (CEA) of measures for reducing nutrients' pollution to WBs. It was carried out by using an Excel based (ECOLAS) model, which includes a defined list of "technical" measures for addressing this problem. At the same time there is reference in the programs of measures (PoM) to additional measures that could be required, although they couldn't be specified due to need for prior research. Growing information and knowledge from implementation of various measures for management of water quality problems suggests that other measures besides those included in the model could potentially be cost-effective for addressing the given water quality problem. However the current approach (with the model) doesn't allow their inclusion in the economic evaluation.

Although hydro-morphological pressures have been identified among the significant water management issues (causing WBs to fail GES), these pressures are not sufficiently addressed by measures in the 1st RBMPs. It is mainly due to need for prior research and analysis to identify effective measures and develop technical specifications for their implementation (which is considered in the 1st PoMs). Consequently, the economic assessment of such measures could not be conducted for the 1st RBMPs. At the same time there is no current applicable approach for the economic evaluation of such measures.

It was concluded that **there is need for an approach that would allow considering new potentially effective measures (besides those included in the model) and performing the economic evaluation of measures in relation to various pressures and water quality problems**.

Experience from the 1st WFD cycle on implementation of the 'supplementary' measures shows that **there are relevant socioeconomic and implementation aspects of measures that can hinder their implementation and that were not taken into account in the evaluation and selection of measures** using the "conventional" CEA. Stakeholders' acceptance and funding availability could be noted among such aspects. Assessment of such aspects for potential measures and taking them into account in the evaluation would support discussions with stakeholders and decision-making to ensure that such measures are selected that could be effectively implemented. It was concluded that **more comprehensive assessment of measures is needed and their evaluation should take into account, besides the cost-effectiveness of measures, other relevant socioeconomic and institutional aspects that can facilitate or hinder implementation of the measures**. At the same time there is no current applicable approach for such task.

The study aimed to develop an approach for the economic assessment and evaluation of measures that would address the needs above.

2 Approach for the economic assessment and evaluation of measures applied in the study

The study focused on **pressures from agriculture and forestry**, which are among the most significant[2] pressures in the Gauja RBD and Latvia overall:

- Pressures causing nutrients' pollution from agriculture and forestry:
  - pollution from point sources (e.g. from animal husbandry buildings, manure storage sites, dairies);
  - pollution from diffuse sources (run-off from agricultural and forest lands due these economic activities);
- Hydro-morphological pressures from agriculture and forestry:
  - from land reclamation (drainage);
  - from polders and straightening of (natural) rivers.

'Supplementary' measures that target these pressures directly or indirectly[3] were included in the analysis.

The approach is based on the **Multi-Criteria Analysis (MCA) methodology**, which commonly aims to combine positive and negative impacts of policy options (e.g. measures) into a single framework to allow their comparison based on multiple criteria. An important feature of the MCA is that it allows comparing options where the impacts are expressed by various, e.g. qualitative, quantitative and monetary data/assessments, and with varying degrees of certainty.

The **criteria for assessment and evaluation of measures** were identified based on analysing experience from the 1st WFD implementation cycle in Latvia, literature review and own expert knowledge. The cost-effectiveness is included among the criteria, however other socioeconomic impacts and implementation aspects of measures are also considered that would be relevant for evaluation and selection of measures. Importance of various criteria was assessed by specialists from relevant national institutions involved in the WFD implementation (more information about the used criteria is provided in the chapters 4.1 and 4.2).

To apply the criteria for the assessment of measures a common **5-category assessment scale** was used for all the criteria, with common general interpretation of the scores from "1" being "very low" to "5" being "very high". Criteria-specific interpretations for each category were also developed (see the chapters 4.3-4.14 for more information).[4]

For the **economic assessment of measures** with the proposed criteria, information collection was conducted to gather available data and assessments. The information was collected from available studies in Latvia and literature review. This formed information base for the assessments

[2] The significance of pressures is defined overall based on the 'risk assessment'. Those pressures are defined as significant that cause WBs failing GES.

[3] Few impact-oriented measures are also included, as well as research, informational and administrative measures without "direct" effect in terms of reducing the pressures or improving the state. See the next section for an approach for selecting measures and a list of measures included in the study, and the Annex 3 for detailed descriptions of the included "technical" measures.

[4] Exceptions were two criteria where the assessment of measures with such a scale was impossible due to information gaps, and more qualitative assessment approach was used instead (see the chapters 4.8 and 4.9 for more information).

of measures (with the used assessment scale), which were developed based on expert judgement (by the project's experts).[5]

Information from this work was collected in a **database of measures**. It covers all the analysed measures and includes information on all relevant characteristics of the measures. The information about the measures is grouped in the database in thematic sections on (i) general characteristics of measures, (ii) application and implementation (incl., for instance, listing relevant stakeholders and assessment of stakeholders' acceptance, assessment of enforcement schemes/practices), (iii) effects and costs and (iv) financial and socioeconomic implications of measures. Also the assessments for all (11) criteria are included in the database. In addition, relevant information gaps are indicated for further work.

The developed assessments were used for the **economic evaluation and prioritisation of the measures**. It was carried out separately for the nutrients' pollution and the hydro-morphological pressures. Two ways of applying the multi-criteria evaluation were explored – a semi-quantitative and quantitative multi-criteria evaluation of the measures.[6]

The semi-quantitative evaluation approach considers socioeconomic "efficiency categories" for evaluation of the measures ("Low"/"Neutral"/"High" efficiency). For each measure it is estimated based on an average score that is calculated from the individual scores for the criteria (with the common 5-category scale). For instance, if the average score for a measure from all the criteria is below "3" (which is lower than "moderate" in the used 5-category scale), a measure has low socioeconomic efficiency. If the average is above 3.5 a measure has high efficiency.

With the quantitative evaluation approach a total score for each measure is calculated as a sum of the individual scores of the criteria. In addition, "weights" are used for each criterion to incorporate relevance of each criterion when evaluating measures (by multiplying the measure's assessment score for a criterion by the "weight" of that criterion, thus giving higher total score for criteria with higher relevance). The weights were obtained from the inquiry of specialists. The measures are afterwards ranked based on these total scores where the most efficient is the measure with the highest score and the least efficient is the one with the lowest score.

The two evaluation approaches provide socioeconomic efficiency assessment and ranking of measures for prioritisation and selection of measures.

[5] More information about the assessment approach and results from the assessment is provided in the section 4.

[6] See the section 5 for more information about the evaluation approach and the results.

3 'Supplementary' measures analysed in the study

This section provides information on the 'supplementary' measures analysed in the study. **A list of measures included in the study** (see also the next table) was built based on the 'supplementary' measures proposed in the 1st RBMPs. Due to the focus of the study on pressures from agriculture and forestry, mainly measures addressing these pressures (directly or indirectly) were selected from the plans. Primarily those measures that are proposed for the Gauja RBD were included. But other measures were also added:

- the national scale 'supplementary' measures proposed in the RBMPs – these measures are not RBD specific however have the same importance for all RBD to reach specified environmental targets;
- 'supplementary' measures proposed based on the CEA for other RBDs but not for the Gauja RBD, since these can be seen as commonly used measures.

In addition to the measures above, new measures were elaborated and included with the initial aim to provide potential options for WBs where measures for reaching the targets were not specified fully in the 1st cycle (e.g. due to the need for prior research) but could be needed in the 2nd cycle. (Such measures include "AD" in their ID number.) It concerns, in particular, the measures for addressing hydro-morphological pressures, which were not sufficiently addressed in the 1st RBMPs. Concerning the nutrients' pollution, the analysis showed that some of the newly added measures can be even more efficient than the currently considered measures.

The work included preparation of detailed **descriptions of the measures.** They were prepared for the 'technical' measures only since they require more profound technical specification and explanation of terms of application.[7] The description for each measure includes a name, brief description and specification of a measure (as well as information sources used for the specification). The detailed descriptions are provided in the Annex 3.

The descriptions and specifications were complemented or corrected for many existing measures in the 1st RBMPs (the introduced changes are highlighted at the beginning of the description for each measure). Review of information about each measure in the 1st RBMPs as well as experience with their implementation in the 1st cycle indicates that clearer definition and specification of some measures is needed. It is important also for proper assessment of their effects and costs for the evaluation of measures. For some measures changes have been introduced concerning both their targeted pressures and impacts and the content (what is prescribed by a measure).

There are measures in the 1st RBMPs that are noted but not specified (e.g. "environment friendly management of drainage systems"). The first descriptions for such measures were developed. The descriptions and specifications were developed as part of the study also for the newly added measures (they were prepared based on review of literature and expert knowledge).[8]

Specific terms of application of the measures (e.g. to which WBs) were not concerned by the study, thus were kept like proposed in the 1st RBMP. It should be noted that for all RBD-specific measures the application is limited to selected WBs (based on the pressures and impact analysis as well as the CEA conducted as part of developing the 1st RBMPs).

[7] See the Annex 1 for typology of the measures used in this study. Majority of the included measures are "technical" measures, but there are other types of measures also – informational, research, regulatory and administrative measures. They were included in the study since the program of measures in reality doesn't consist of the "technical" measures only.

[8] The descriptions have been developed by Loreta Urtane ("L.U. Consulting" Ltd.) and Kristine Pakalniete ("AKTiiVS" Ltd.).

The list of measures included in the study is provided in the table below. The table also indicates the measures for which the descriptions are provided (in the Annex 3), as well as what improvements in the descriptions are introduced as part of the study.

Table 3.1 A list of 'supplementary' measures included in the study.

* Description of a measure has been complemented (+) / considerably corrected (++) / elaborated (+++) as part of the study.

ID	Name of Measure	Description is provided (in Annex 3)	Improvements introduced as part of the study*
LV1	Arranging environmentally safe manure storage facilities	+	+
LV2	Construction of biological WWTP in dairies	+	
LV3	Crop fertilisation planning	+	+
LV4	Winter green areas and stubble fields	+	+
LV5	Green manure	+	+
LV6	Buffer zones in agricultural land:		
LV6.1	Agricultural land buffer zones for water courses and bodies	+	++
LV6.2	Agricultural land buffer zones for drainage systems	+	++
LV7	Good felling practice	+	
LV8	Forest buffer zones	+	+
LV9	Proposals to reduce impact of agricultural activities		
LV10	Research and proposals for lakes with unknown reason "at risk"		
LV11 (AD)	Nutrients' retention ponds in AGR drainage systems	+	+++
LV12 (AD)	Sedimentation ponds to reduce impact of soil erosion from FOR activities	+	+++
LV13 (AD)	Sedimentation ponds to reduce impact of soil erosion from AGR lands	+	+++
LV14 (AD)	Sedimentation ponds as part of environment friendly management of FOR drainage systems	+	+++
LV15	Improving ecological functionality of lakes	+	++
LV16	Investigation about measures for regulated rivers		
LV17	Development of technical provisions for FOR drainage systems		
LV18	Development of technical provisions for AGR drainage systems		
LV19	Development of technical provisions for POLDERS		
LV20	Environment friendly management of FOR drainage systems	+	+++
LV21	Environment friendly management of AGR drainage systems	+	+++
LV22	Environment friendly management of POLDER systems		
LV23	Development of River Basin Management Information system		
LV24	Educational and Informational measures		
LV25	Organising public participation		
LV26 (AD)	Improving ecological processes when maintaining regulations of rivers	+	+++
LV27 (AD)	Improving ecological functionality of regulated rivers by naturalisation of river bed	+	+++
LV28 (AD)	Management of Protected Belts of water courses/bodies	+	+++

4 Multi-criteria assessment of the measures

The proposed approach considers assessment of measures from multiple perspectives, which are considered by assessment criteria. The criteria aim to capture the main positive and negative impacts and implementation aspects of measures, and the assessment of measures by using such criteria can substantiate prioritisation and selection of measures for the program of measures.

The criteria used in the study were identified based on analysing experience from the 1st WFD implementation cycle in Latvia, literature review and own expert knowledge. Those seen as potentially relevant for the evaluation and selection of measures were included in the list (see the chapter 4.1). They were afterwards given to specialists from various institutions for assessing their significance (see the chapter 4.2). There were no criteria that are seen commonly as not relevant. Hence all the criteria were kept for further analysis – the assessment and evaluation of measures[9].

Information collection was conducted to gather available data and assessments for the measures (listed in the previous section) to apply the criteria. The information was collected from available studies in Latvia and literature review. Even with rather profound inventory of available information, it turned out insufficient for developing the assessments for all the criteria and measures. A special study would be needed to develop assessments for specific criteria or measures (in particular, for the newly specified and added measures). One of aims of the information collection was to identify relevant information gaps that should be filled in the future for applying the proposed approach.

The assessments of the measures by using all the criteria were developed based on expert judgement (by the project's experts). The assessment results are presented for each criterion in the chapter 4.4.

4.1 Criteria for the assessment of measures

The following criteria for assessment and evaluation of measures were considered in the study:

C1 Cost-effectiveness of a measure – commonly calculated as annual costs of a measure divided by its effect (e.g. EUR / 1 kg of reduced N). It allows comparing various measures and selecting those that ensures the "least cost way" to specified environmental objective. The cost-effectiveness is estimated here taking into account only effect on the "targeted" water quality parameter/pressure (e.g. nutrients' pollution) and financial costs of a measure (i.e. investment, operation and maintenance costs), without taking into account other effects and types of costs of a measure since these impacts are considered in other criteria.

C2 Time until the effect after making a measure operational – describes time period after implementing a measure within which the environmental improvement takes place.

C3 Multiple effects of a measure – effects on various WFD water quality elements, e.g. on various physicochemical quality and/or hydro-morphological quality elements. They are accounted if a measure improves state in relation to more than one water quality element.

C4 Economic costs of a measure – besides the direct financial costs measures may create other costs to those who implement them, for instance, as foregone income due to yield loss when converting arable land to other land use type. It should be note that some measures may create

[9] An exception was criterion "Time until the effect after making a measure operational", for which the assessments of measures were not elaborated due to its relative lower relevance and limitations of this study.

also economic gains (e.g. saved costs on fertilisers thanks to more efficient fertilisation planning and application). Both are considered under this criterion.

C5 Administrative costs of implementing a measure – costs of administrations for monitoring, control, enforcement etc.

C6 Indirect costs and wider negative socioeconomic impacts can be related to negative "secondary"/wider impacts on the sectors who implement the measures and the related sectors, distributional impacts in terms of geographical and social distribution of the costs (e.g. impact on vulnerable groups of the society).

C7 Certainty of the effectiveness and costs' assessments of a measure is low in cases when the assessments are very rough/uncertain and is high in cases when there is good information & knowledge about what the actual costs and effects of measures are. This is relevant since the effectiveness and costs' estimates are used for prioritising measures and deciding on which measures should be implemented.

C8 Socioeconomic benefits from environmental improvements (from water-related and environment-related side effects) – benefits to society and economy from improved water and environmental quality achieved by implementing a measure. "Environment-related side effects" create benefits if a measure gives also improvements besides those directly related to the water environment, e.g. has a positive impact also on biodiversity, soil quality, air emissions etc.

C9 Availability of enforcement (incl. controlling) scheme(s) for implementing a measure – the enforcement requires various instruments and institutional structures to make a measure "operational". Including, instruments for implementation of a measure (e.g. setting a measure as "cross-compliance" requirement for the CAP, setting a compensation payment covering the costs of a measure), institutions and schemes for administration, control, penalties.

C10 Acceptance by stakeholders concerned by implementing a measure – the level of acceptance is measured from "low" to "high". The acceptance may be different for various measures, for instance, due to lack of knowledge about effects and/or costs of a measure, distrust to the positive environmental effect, different socioeconomic interests of various stakeholders etc. Practice shows that the acceptance is an important precondition for making a measure operational.

C11 Certainty in funding availability is low if possible funding source is unclear, and high if a funding instrument/source is known and there is confidence that the funding will be allocated from there.

It should be noted concerning the **various environmental effects and types of costs of measures** that in theory they all should be considered **in the cost-effectiveness assessment of measures**. Also according to the WATECO guidance document[10], the cost-effectiveness assessment of measures should incorporate various costs, effects and other impacts of measures. However, in the given approach, various impacts are separated and only primary ("targeted") environmental effect and financial costs of measures are considered for estimating the cost-effectiveness but other effects and costs are included under other criteria. It was done to account them properly for each measure and to keep transparency on what is assessed and what could not be assessed due to information limitations. This issue appears important in light of available information base to be able to assess various types of costs and effects in a systematic manner (accounting the same types of effects and costs) for all analysed measures, not only for those where information allows estimating them. This is relevant for proper comparison and ranking of measures. Such situation should be avoided that information gaps impact ranking of measures due to

[10] WATECO (2003) *"Economics and the environment. The implementation Challenge of the Water Framework Directive. Guidance document and accompanying documents to the guidance".*

misrepresented assessment of effects/costs for some measures. The used approach gives flexibility of including/excluding specific impacts (criteria) in the evaluation of measures depending on data availability and relevance and provides larger transparency on how various impacts are taken into account in the evaluation of measures. The approach applied in this study account other than "direct" effects and costs in the evaluation and prioritisation of measures by other included criteria, and each criterion is examined for all the measures supporting systematic and transparent assessment.

4.2 Assessment of importance of the criteria based on inquiry of specialists

Importance of the various criteria was assessed based on an inquiry of specialists from various institutions. The inquiry aimed to collect opinions of specialists from relevant national institutions related to the WFD implementation in Latvia[11] about importance of various criteria for the socioeconomic evaluation and selection of measures to improve water status in Latvia. It was conducted in June of 2013. The information was collected by a questionnaire (provided in the Annex 2). It listed all (11) criteria[12] for evaluation of measures. The participants were asked to assess each criterion by a scale from 1 "low relevance" to 5 "high relevance" and to mark 5 the most important criteria.

The questionnaire was filled by all addressed specialists (12 in total) from institutions that were selected to represent the most important types of actors of the RBMP. The participants had the following "profiles" (2 specialists of each profile were included):

- "Environmental policy specialist" (working on implementation of the Water Framework Directive (WFD) and other environmental policies);
- "Environmental specialist" (working with assessments of pressures, state and/or measures in relation to water ecosystems);
- "Concerned actor" (representatives from agriculture and forestry sector[13] responsible for/involved in implementation of the measures);
- "Relevant stakeholder" (being active in the field of water and biodiversity protection);
- "Economist of WFD" (working with the economic aspects of the WFD).

Brief summary on results of the inquiry is provided below.

The following criteria can be noted as the most highly scored overall – **"Socioeconomic benefits from environmental improvements" and "Acceptance by stakeholders"**. They are assessed with "4" or "5" (high relevance) in 10 and 9 cases respectively out of all 12 responses and they are named among 5 the most important criteria in 8 cases. Their average score is 4.3 and 4.2 respectively and "5" is the most frequently assigned score for them. No one assessed them with "1"or "2" (low relevance).

Three other criteria were scored similarly high – **"Cost-effectiveness of a measure", "Multiple effects of a measure" and "Certainty in funding availability"**. They are assessed with "5" or "4" in 10/9/9 cases respectively out of all 12 responses and are named among 5 the most important criteria in 7/8/8 cases. Their average score is 4.3/4.1/4.0 respectively and "5" is the most

[11] Similar inquiry was conducted in Estonia also.

[12] The 12th option in the questionnaire was „other, please specify". It was filled in two cases only, thus no additional relevant criteria were identified.

[13] Two institutions for each sector were included in the inquiry since analysis in this project's task focused in particular on measures for reducing pressures from agriculture and forestry.

frequently assigned scores also for them. However, they have received few scores of "1" or "2" (in 1/1/2 cases respectively).

The results shows that the five criteria above form a group of commonly highly scored criteria (see also the next figure). It can be concluded overall that the **socioeconomic and environmental benefits, stakeholders' acceptance, cost-effectiveness of measures and availability of funding are seen as the priority issues for the evaluation and selection of measures.**

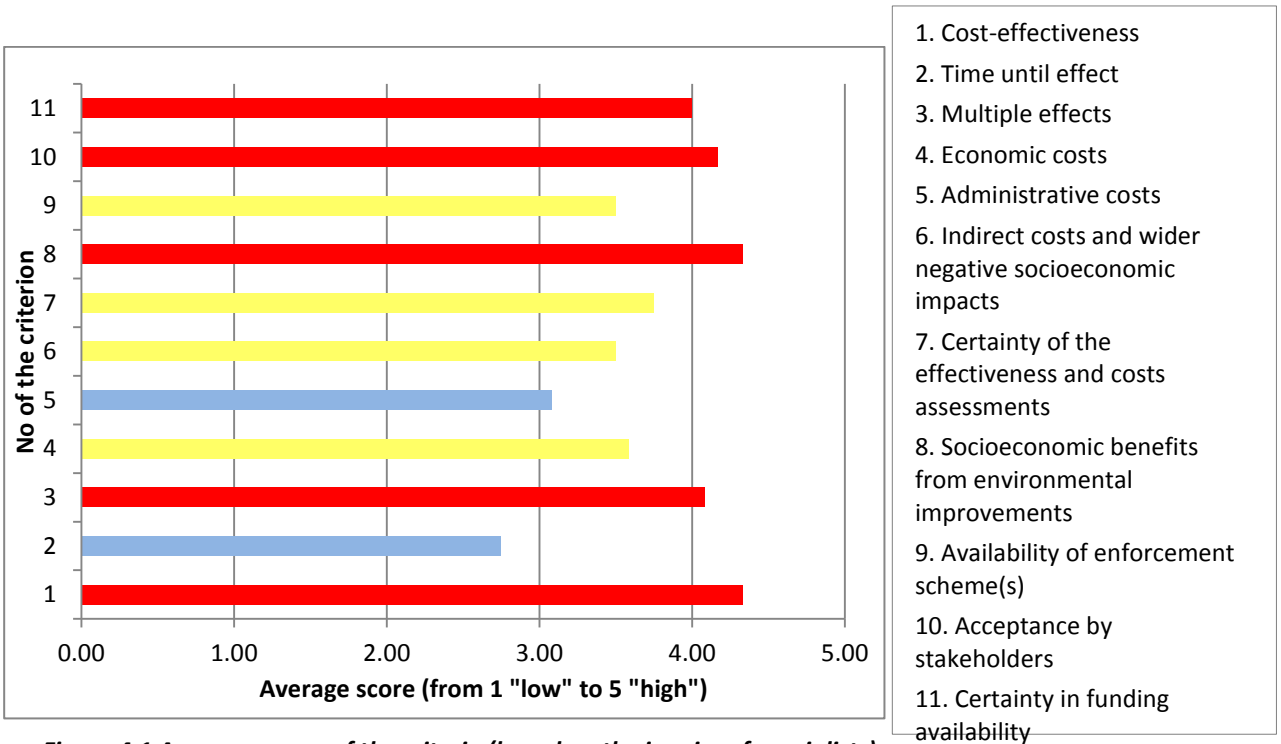

Figure 4.1 Average scores of the criteria (based on the inquiry of specialists).

The following criteria can be noted as next by importance – "Certainty of the effectiveness and costs' assessments of a measure" and "Availability of enforcement (incl. controlling) scheme(s) for implementing a measure" (the criteria No 7 and 9) with an average score 3.75 and 3.5 respectively and with the scores "4" or "5" (high importance) assigned in 7 cases out of all. They have received scores "1" or "2" in few cases only (1 and 2 respectively).

Quite similar assessments were assigned also to the criteria "Indirect costs and wider negative socioeconomic impacts" and "Economic costs of a measure" (the criteria No 4 and 6). They have received the scores "4" or "5" in 5 cases and only in few cases they are assigned low relevance (the scores "1" or "2").

Although these four criteria are overall scored lower than the first group, they are seen as important, thus should be considered when evaluating and selecting the measures.

Two criteria from the list have received lower average score (marked with blue columns in the figure above), besides the individual assessments of their importance are quite opposite overall. The criterion "Administrative costs of implementing a measure" received the score "4" or "5" in 5 cases and was marked among the 5 most important criteria in 3 cases. At the same time it was assessed with low importance ("1" or "2") in 5 cases. The differences in individual assessments might be explained by the fact that this type of costs are usually borne to specific actors (concerned by the administrative actions e.g. monitoring, control, enforcement) thus they could be seen as more important by those who are affected. Another reason could be also that there might be limited awareness on the magnitude of these costs since they are sometimes "hidden" in the current budgets/responsibilities of the concerned institutions.

The criterion "Time until the effect after making a measure operational" received the lowest score overall. Although it is even marked among 5 the most important criteria in 2 cases (by environmental specialists/scientists) and was assessed with the scores "4" or "5" in 4 cases out of all, the most frequently assigned score (Mode) is "1" (in 4 cases).

This result indicates that **these two criteria should not be ignored in the evaluation of measures, but a simplified approach for considering them in the evaluation could be applied.**[14]

Based on the results of the inquiry all criteria can be grouped into the following groups:

Criteria of highest priority	No 1, 3, 8, 10, 11
Important criteria	No 4, 6, 7, 9
Criteria with differently viewed importance	No 2, 5

4.3 Applying the criteria for the assessment of measures

To apply the criteria for the assessment of the measures a **5-category assessment scale was used for each criterion**. Criteria-specific interpretations for each category were also developed (see the table below). Exceptions were the criteria C5 and C6 where the information base was not sufficient for applying such 5-category scale and a simplified assessment scale/approach was used.

Table 4.1 Assessment categories (with 5-category scale) for the criteria used in the analysis.

Criteria	Specifications of the categories
1. Cost-effectiveness (CE)	For the effectiveness: from 1 "very low load reduction efficiency" to 5 "very high load reduction efficiency", for the direct (financial) costs: from 1 "very high" to 5 "very low". (Further quantitative specifications for the categories are developed, see the chapter 4.4). A matrix is used for deriving CE scores (see the chapter 4.4.4).
2. Time until effect	From 1 "long" to 5 "short" (although the measures were not assessed with this criterion).
3. Multiple effects	From 1 "low multiple effects" to 5 "high multiple effects" (further specification for the categories is developed, see the chapter 4.6).
4. Economic costs	For the 'economic costs': from 1 "very high" to 5 "very low". For the 'economic gains': from 1 "very low" to 5 "very high".
5. Administrative costs	From 1 "very high" to 5 "very low" (although measures could not be assessed with these categories due to lack of information).
6. Indirect costs and wider negative socioeconomic impacts	"Low" / "Moderate"/ "High" possible negative impacts. Indication of considerable possible distributional impacts.
7. Certainty of the effectiveness and costs' assessments	For both the effectiveness and costs: from 1 "very low" to 5 "very high" certainty (further specification for the categories is developed, see the chapter 4.10).
8. Socioeconomic benefits from environmental improvements	From 1 "low possible benefits" to 5 "high possible benefits".
9. Availability of enforcement scheme(s)	From 1 „not existing" to 5 „fully operational".
10. Acceptance by stakeholders	From 1 „low" to 5 „high".
11. Certainty in funding availability	From 1 „low" to 5 „high".

[14] For instance, both characteristics are reviewed for measures (like screening, without developing detailed assessments), and they are indicated for those measures, where expected to be significant (e.g. significant administrative costs, very long time-lag for the effect) to support selection of measures.

The average relevance scores of the criteria obtained from the inquiry of specialists were latter used as **"weights" to incorporate relevance of each criterion when evaluating measures** (by multiplying the measure's assessment score for a criterion by the "weight" of that criterion, thus giving higher total score for criteria with higher relevance).

The chapter 4.4 provides results on the conducted analysis to assess the measures according to the analysed criteria.

4.4 Cost-effectiveness of measures (C1)

4.4.1 Relevance of the criterion

The relevance assessment based on the inquiry of specialists is provided in the table below. It shows that this criterion is commonly highly scored and is ranked among 5 the most important criteria for evaluation and selection of 'supplementary' measures (together with the socioeconomic and environmental benefits, acceptance by stakeholders and certainty in funding availability).

Table 4.2 Relevance assessment of the criterion based on results of the inquiry of specialists (2013).

Total number of responses – 12. The responses included assessment of each criterion by a scale from 1 "low relevance" to 5 "high relevance" and marking 5 the most important criteria from the listed (11 in total).

No of responses	12
SUM	52
Average	4.3
No of cases "among 5 the most important"	7
No of scores "4" and "5"	10
Mode (most frequently assigned score)	5
Median (middle of data row)	5
Range: Min/Max	1/5
No of scores "1" and "2"	1
Group	Criterion of highest priority

The "cost-effectiveness" overall consists of the following elements: environmental effectiveness of a measure, costs of a measure and calculated cost-effectiveness of a measure (the costs divided by the effectiveness). Each of these elements is discussed further.

4.4.2 Environmental effectiveness of measures

4.4.2.1 Definition used in the study

Water quality elements as specified by the WFD were used as basis to assess the effectiveness of measures (see the next table).

Although status of WBs needs to be assessed based on biological quality elements, measures are commonly identified to address specific pressures and activities creating them (e.g. nutrients' pollution load to water bodies from crop production and animal breeding, affected hydro-morphological characteristics of rivers due to river straightening for agriculture or forestry). Thus measures are targeted to specific pressures. The "targeted pressure" in this study is the one for which a measure would primarily be selected for potential inclusion in the program of measures.

Relevant pressures from agriculture and forestry (covered by this study) have direct impact on physicochemical and/or hydro-morphological water quality elements. Therefore the "targeted effect" is related to these water quality elements. The "targeted effect" (in terms of targeted quality element(s)) was specified for each measure.

Table 4.3 WFD water quality elements used in the study for assessing effectiveness of measures.

Groups of water quality elements	Water quality elements	Comments
Biological elements	Fish	Composition, abundance and age structure of fish fauna (for rivers, lakes, transitional waters).
	Macrophytes	Composition and abundance of aquatic flora (for rivers, lakes, transitional waters, coastal waters).
	Phytoplankton	Composition, abundance and biomass of phytoplankton (for lakes, transitional waters, coastal waters).
	Macro-invertebrates	Composition and abundance of benthic invertebrate fauna (for rivers, lakes, transitional waters, coastal waters).
Chemical and physicochemical elements supporting the biological elements	Nutrients	N and P
	Specific substances	Priority substances
	Other elements	Thermal conditions, oxygenation conditions, salinity (for rivers, lakes, transitional waters and coastal waters), transparency (for lakes, transitional waters and coastal waters).
Hydro-morphological elements supporting the biological elements	Hydrological regime	Flow capacity and dynamics.
	Continuity (for rivers)	Incl. river-floodplain connection.
	Morphology	Morphology of bed, banks, riparian zone, incl. sediment structure, structure of banks.

The effectiveness of measures was evaluated by extent to which a measure reduces load of the "targeted pressure" (load reduction efficiency) in relation to the targeted water quality element. The load reduction efficiency was estimated with a scale from "1" being "very low" to "5" being "very high" load reduction efficiency (specific interpretation of each category was also developed).

Most measures impact more than one water quality element, however these other effects are accounted by separate criterion (C3 "Multiple effects of measures").

4.4.2.2 Assessment of the effectiveness of measures

Work for developing the assessment involved collecting available quantitative estimates on effects of measures. For the measures clearly specified in the 1st RBMPs such estimates were available from the used (ECOLAS) model, although for some measures they were complemented with recent information from Latvia. For newly specified measures such information was taken from literature and implementation cases in Latvia if exist. This information was used as basis for assessing effectiveness of each measures based on expert judgement (by the project's experts). The result is provided in the next table.

It should be stressed that the effectiveness assessment needs to be viewed together with the technical specification of a measure (see the Annex 3), since the effectiveness can vary significantly depending on "technical design" of measures. Due to this reason these specifications were further clarified and developed (for newly specified measures) as far as possible as part of the study.

Table 4.4 "Targeted effect" and assessment of effectiveness of the measures. *(Source: Various information sources, the assessment developed by the project's experts.)*

Notes:

The "targeted effect" in relation to hydro-morphology (Hm) may concern (i) morphology (sediments), (ii) hydrology and/or (iii) continuity.

The effectiveness is assessed as load reduction efficiency (for the "targeted" water quality element) with the 5-category scale, where 1 "very low", 2 "low", 3 "moderate", 4 "high" and 5 "very high" reduction efficiency. For nutrients' pollution load, for instance, the score "4" means 40-50 % and "5" means 50 % and higher load reduction efficiency.

The measures without direct effect were not assessed, thus are not included in the table (e.g. research, informational, regulatory & administrative measures).

Name of measure (M)	Type of "targeted effect"	Comments on the "targeted effect"	Assessment (from 1 to 5)	Comments on the assessment
LV1 Arranging environmentally safe manure storage facilities	Physicochemical	Reduced loads of N and P (from a source).	5	For isolated manure storage facilities (not storage on field). Effect of the M. was calculated in the 1st RBMPs based on ECOLAS model, which considers building of manure storage facilities. Content of the M. was changed latter by including also manure storage on field. But the quantitative estimate of effect has been kept unchanged. Thus, it might be the case that the effect is overestimated and the efficiency of measure might be lower in reality.
LV2 Construction of biological WWTP in dairies	Physicochemical	Reduced loads of N and P (from a source).	4 (for N) 5(for P)	
LV3 Crop fertilisation planning	Physicochemical	Reduced loads of N and P (from a source).	3	Effect of the M. was calculated in the 1st RBMPs based on ECOLAS model, which considers set of activities (incl. also crop rotation plan), while RBMPs refers only to crop fertilisation planning. Therefore the efficiency might be lower in reality.
LV4 Winter green areas and stubble fields	Physicochemical	Reduced loads of N and P (from a source).	4	
LV5 Green manure	Physicochemical	Reduced loads of N and P (from a source).	3	
LV6.1 Agricultural land buffer zones for water courses and bodies	Physicochemical	Reduction of nutrient load by accumulation of N and P.	2 for 8m, 5 for 16m width (for N); 5 for 8m and wider (for P)	Assuming the "voluntary" width 5/10 m (depending on size of WB). If the width is 3m only, the efficiency is much lower (1 for N, 3 for P). The reduction efficiency is very sensitive to proper implementation of the M. (e.g. it declines by half if banks overgrow with White Alder (Alnus incana)).
LV6.2 Agricultural land buffer zones for drainage systems	Physicochemical	Reduction of nutrient load by accumulation of N and P. The M. gives significant reduction of hydro-morphological load by accumulation of soil erosion products.	1 (for N) 1 (for P)	Assuming 2m width. The reduction efficiency for this width is very high (5) for reduction of soil erosion effects. To reach the same efficiency for nutrients, buffer zone has to be enlarged to 6-10m. The reduction efficiency is very sensitive to proper implementation of the M. (e.g. it declines by half if banks overgrow with White Alder).

Name of measure	Type of targeted effect	Comments on the targeted effect	Assessment (from 1 to 5)	Comments on the assessment
LV7 Good felling practice	Physicochemical	Reduction of nutrient load by accumulation of N and P.	4	Assessment based on the reduction efficiency according to the ECOLAS model. The effect depends on many factors (proportion of area logged, watershed, time between event and logging, storm size, etc.).
LV8 Forest buffer zones	Physicochemical	Reduction of nutrient load by accumulation of N and P.	3	10 m width is assumed. In cases where riparian zone is overgrown with White Alder (30-40 years old), the efficiency can be increased up to "5" if this M. is combined with [LV28] on management of Protected Belts.
LV11 (AD) Nutrients' retention ponds in AGR drainage systems	Physicochemical	Reduction of nutrient load by accumulation of N and P within the pond.	2 (for N) 4 (for P)	
LV12 (AD) Sedimentation ponds to reduce impact of soil erosion from FOR activities	Hm: Morphology (Sediment)	Reduction of hydro-morphological load by accumulation of soil products within the pond.	5	The efficiency of a pond decreases during operation when it fills up with sediments, therefore site specific maintenance (e.g. cleaning) is needed to keep the efficiency. The rate at which sedimentation pond become filled up depends on the pond dimensions and local factors like discharge and predominant soil type. The residence time for sediment accumulation from higher to lower is: Humified peat -> silt, very fine sand or fine sands -> clay.
LV13 (AD) Sedimentation ponds to reduce impact of soil erosion from AGR land	Hm: Morphology (Sediment)	Reduction of hydro-morphological load by accumulation of soil products within the pond.	5	
LV14 (AD) Sedimentation ponds as part of environment friendly management of FOR drainage systems	Hm: Morphology (Sediment)	Reduction of hydro-morphological load by accumulation of soil products within the pond.	5	
LV15 Improving ecological functionality of lakes	Physicochemical	(1) Reduction of existing nutrient amounts by limitation of overgrow with macrophytes (cutting of waterplants) and (2) limitation of nutrient load by limitation of overgrow with bushes in riparian part of WB (cutting of bushes).	from 2 to 5 (as an interval)	The efficiency depends on what activities (specific set of activities) and with what purpose are required in each case. A set may commonly include the activities specified under this M. However, investigation and a "technical project" is needed, which should be developed in the future for each case and would specify the most appropriate set of activities and technical provisions for their application.
LV20 Environment friendly management of FOR drainage systems (LV20.2)	Hm: Hydrology Hm: Continuity	Reduced hydro-morphological pressure from drainage systems on affected surface WBs.	<u>For [LV20.2]:</u> 3 (if beaver caused problems exist) 1 (other cases)	The efficiency assessment only for [LV20.2]. The efficiency depends highly on whether the beaver caused problems exist (affect significantly many water quality elements). If this is the case, the M. (its Activity 2, see the description) eliminates the negative consequences resulting in considerable improvement.

Name of measure	Type of targeted effect	Comments on the targeted effect	Assessment (from 1 to 5)	Comments on the assessment
LV21 Environment friendly management of AGR drainage systems (LV21.1 and 21.2)	Physicochemical	(1) Improved self-purification capacity - better limitation of nutrients and therefore reduced nutrients' pollution load from drainage systems to affected surface WBs. (2) Improved drainage capacity - longer time periods between regular maintenance and therefore better condition for natural re-growth and stabilisation of ecosystem.	<u>For [LV21.1]:</u> 2 (for N), 4 (for P) <u>For [LV21.2]:</u> 3 (for N and P)	The efficiency assessment for the maintenance [LV20.2]: It depends on appropriate ditch management techniques and specific requirements. It can be achieved only with the "environment friendly" maintenance approach as prescribed by this M. (see the specification of M.). It is not achieved with the "conventional" amelioration practice.
LV22 Environment friendly management of polder systems	Hm: Hydrology Hm: Morphology (Sediment) Hm: Continuity	Reduced impact of polder system on ecological quality of WB.	NK	(Actual measures are not specified yet.)
LV26 (AD) Improving ecological processes when maintaining regulations of rivers	Hm: Morphology (Sediment) Hm: Hydrology	(1) Establishment of aquatic communities normally associated within definite type of WB and (2) enforced self-purification capacity. This would give reduced nutrient load also.	3	The efficiency of M. is highly sensitive to proper implementation of the M. It is not achieved with the "conventional" amelioration practice. The conventional practice of cleaning of regulated rivers should only be undertaken where it is necessary to clear drainage outfalls. Where maintenance of regulated rivers is required it should be undertaken in rotation to avoid excessive lengths of cleared vegetation and allow natural re-growth. Conditions for the "proper" implementation should be specified by [LV16] and [LV18] in particular.
LV27 (AD) Improving ecological functionality of regulated rivers by naturalisation of river bed	Hm: Hydrology Hm: Morphology (Sediment)	(1) Establishment of hydrological regime and aquatic communities normally associated within definite type of WB and (2) enforced self-purification capacity. This would give reduced nutrient load also.	5	The efficiency is site specific and depends on degree of modifications. Therefore a technical project has to be prepared for each case to specify the most appropriate set of activities and technical provisions for their application. It is noted that activities have to be targeted to improve functionality of river and minimise hydro-morphological alterations. Particular species and biotopes' specific activities not always reach high efficiency with respect to naturalisation of river.
LV28 (AD) Management of Protected Belts of water courses/bodies	Hm: Hydrology Hm: Morphology (Sediment) Hm: Continuity Physicochemical	(1) Reduced soil erosion in leafless vegetation period, (2) mitigation of tree jams, which interrupts continuity of river and intensify sedimentation processes and (3) reduced nutrient leakage from riparian zone.	5	The efficiency assessment is valid for cases with the described problems caused by lack of maintenance of the Protected Belts. In particular, where river bank is overgrown with White Alder in age of 30-40 years. This is common case in non-used agricultural lands, can be also in forest lands (then this M. can be used complementary to [LV8]).

4.4.2.3 Relevant gaps for future work

The following issues need to be noted where **information gaps** limit appropriate assessment of the effectiveness of the measures:

1. Quantitative effectiveness estimates used in the RBMPs don't correspond to specifications of measures that have been changed over time. The effectiveness needs to be re-evaluated according to (changed) specification of a measure for LV1 and LV3.
2. Insufficient/unclear specification of a measure, where more specified requirements should be developed (requiring also additional research in some cases). It concerns the measures LV4, LV5, LV7, LV8, LV11, LV21.2, LV26.
3. Location-specific effectiveness, when additional research is needed to assess the effectiveness in connection to relevant site-specific characteristics and/or further technical specifications of measures need to be developed to ensure their appropriate implementation for achieving expected efficiency. It can be noted, in particular, concerning the measures LV6, LV12, LV13, LV14, LV20.2.
4. Case-specific effectiveness, when it depends highly on a set of activities required in each specific case and where investigating each case and specifying the most appropriate activities and ways of their implementation is needed. This concerns the measures LV15, LV27.

Data on the effectiveness are based on experiences from other countries for almost all measures. For such measures national data should be obtained from monitoring in future research.

4.4.3 Financial costs of measures

4.4.3.1 Definition used in the study

Only direct 'financial costs' of measures are considered for the criterion on the cost-effectiveness of measures. Other costs (e.g. direct 'economic costs', 'administrative costs', 'indirect costs'/wider negative socioeconomic impacts) are separated under other criteria (C4, C5, C6). Such approach allows accounting various impacts in systematic manner for each measure and, at the same time, keeping transparency on what is assessed and what could not be assessed due to information limitations. Since it is common situation in practice, that various types of "other" costs are difficult to estimate, including due to lack of information. The given approach aims to avoid situation that the same impact is not evaluated and accounted systematically for all measures due to information gaps and that it impacts prioritisatio of measures. With the given approach the "other" costs are still accounted – by the multi-criteria evaluation of measures.

The 'financial costs', depending on a measure, can include investment costs, operation and maintenance costs or one-off costs of implementing a measure.

It should be noted that there could be measures that don't create the 'financial costs' but only direct 'economic costs' (LV8 "Forest buffer zones" from the analysed in this study).

The 'financial costs' of such types of measures as "regulatory & administrative" measures, "informational" and "research" measures are accounted under the 'administrative costs' (see the Annex 1 for the typology of measures and the chapter 4.8.2 for definition of the 'administrative costs' used in this study).

4.4.3.2 Assessment of the costs of measures

The work for assessing the 'financial costs' of the measures involved the following steps:

1. Collecting available quantitative (monetary) estimates on the 'financial costs' of the measures;
2. Rough estimation of total costs per economic activity unit (e.g. an "average farm" in Latvia);
3. Assessment of the costs using the 5-category scale based on expert judgement.

The first two steps formed "evidence base" for the assessment using the 5-category scale, which was used afterwards for estimating the cost-effectiveness of measures (for the criterion C1).

The quantitative monetary estimates were collected from the 1st RBMPs (based on the ECOLAS model) and literature. In addition, for the sedimentation ponds' measures (LV12-14) some unit figures were obtained for Latvia where implementation experience exists (in the State forests). This allowed deriving the first rough cost estimates for these measures. For the retention ponds (LV11) the cost estimates from literature were reviewed and used. There were no cost estimates available for other newly specified measures (LV15, LV20-22, LV26-28). Although implementation cases of these measures exist in Latvia, a special study would be needed for deriving appropriate cost estimates (that could be used for such national/RB scale assessments). Consequently, the costs of these measures could not be assessed also with used 5-category scale.

The available quantitative estimates were commonly expressed as costs per unit that was specific for each measure (e.g. costs per 1 ha of arable land, 1 ha of clear-cutting area, 1 animal unit, 1 ha of pond area etc.). In practice, these unit estimates are afterwards multiplied with the number of units to which a measure is applied to calculate total costs of a measure. However, application of a measure needs to be known for this (e.g. number of concerned WBs, number of units). But the given study didn't aim this type of analysis. Due to the different cost units used for each measure they cannot be compared based on these "unit costs" only. To be able to compare the measures, the costs of each measure were estimated per common unit – an "average" economic (activity) unit in Latvia that would be concerned by implementing a measure (e.g. for an "average" crop cultivation/animal breeding farm in Latvia, for a felling area/site, for a project of renovating/reconstructing drainage system). Since such estimates are based on the same unit (costs per "average" concerned economic unit) they are comparable. These estimates were used as "evidence base" for developing the assessment with the 5-category scale.

The table below provides assessment of the 'financial costs' of the measures with the used 5-category scale (from "1" meaning the costs are "very high" to "5" meaning the costs are "very low")[15]. The assessment has been developed based on expert judgement.

[15] A quantitative specification for each category was also developed, for instance, the costs are "very low" if they are below 50 EUR per year per "economic unit", they are "moderate" with 200-500 EUR per year and "very high" if they are above 1000 EUR per year per "economic unit".

Table 4.5 Assessment of the 'financial costs' of measures *(Source: Various information sources, the assessment developed by the project's experts.)*

Note: Only those measures are included in the table that involve the 'financial costs' ("NK" means that they could not be assessed due to lack of information). These are all "technical measures" except LV8 "Forest buffer zones" (with no 'financial costs', only 'economic costs'). The 'financial costs' of other types of measures (e.g. administrative, informational, research) are considered under 'administrative costs' (see the criterion C5) according the approach of this study.

[1] Based on definition of the measure and its (unit) costs according to the 1st RBMPs (ECOLAS model).

[2] Costs according to the initial definition of the measure (in the ECOLAS model) – isolated manure facilities (not storage on field).

[3] No 'financial costs' assumed in the RBMPs (in the ECOLAS model). However, the measures could involve such costs (although could not be assessed due to lack of information).

ID	Name of measure	Assessment (1-5)	
LV1	Arranging environmentally safe manure storage facilities [1], [2]	very high	**1**
LV2	Construction of biological WWTP in dairies [1]	moderate / high	**3/2**
LV3	Crop fertilisation planning [1]	moderate	**3**
LV4	Winter green areas and stubble fields [1]	moderate	**3**
LV5	Green manure [1]	very high	**1**
LV6.1	Agricultural land buffer zones for water courses and bodies [1], [3]	NK	**NK**
LV6.2	Agricultural land buffer zones for drainage systems [1], [3]	NK	**NK**
LV7	Good felling practice [1], [3]	NK	**NK**
LV11 (AD)	Nutrients' retention ponds in AGR drainage systems	very high	**1**
LV12 (AD)	Sedimentation ponds to reduce impact of soil erosion from FOR activities	very low	**5**
LV13 (AD)	Sedimentation ponds to reduce impact of soil erosion from AGR lands	very low	**5**
LV14 (AD)	Sedimentation ponds as part of environment friendly management of FOR drainage systems	very low / low	**5/4**
LV15	Improving ecological functionality of lakes	NK	**NK**
LV20	Environment friendly management of FOR drainage systems	NK	**NK**
LV21	Environment friendly management of AGR drainage systems	NK	**NK**
LV22	Environment friendly management of polder systems	NK	**NK**
LV26 (AD)	Improving ecological processes when maintaining regulations of rivers	NK	**NK**
LV27 (AD)	Improving ecological functionality of regulated rivers by naturalisation of river bed	NK	**NK**
LV28 (AD)	Management of Protected Belts of water courses/bodies	NK	**NK**

4.4.3.3 Relevant gaps for future work

The results above show that **considerable further work is required for collecting data and estimating 'financial costs' of measures for the next RBMPs**.

For the measures specified in the 1st RBMPs:

- Possible 'financial costs' should be assessed for the measures LV6 an LV7 (only 'economic costs' are accounted for these measures in the 1st RBMPs).

- Costs for the measure LV1 “Arranging environmentally safe manure storage facilities” and LV3 “Crop fertilisation planning” should be re-evaluated, since content of these measures has been changed comparing to the initial definition in the ECOLAS model.
- Further technical specifications of some measures are needed (e.g. LV5, LV6, LV7, LV8) as well as collecting information on implementation practice (e.g. LV4 and LV5) and sequential re-evaluation of their costs

For the newly specified and added measures, a separate study would be needed for estimating their costs for the RBMPs. National data need to be collected from implementation cases in Latvia and “average costs” calculated for each measure, which afterwards could be used also for estimating total costs of each measure (considering its application according to the RBMPs). This concerns in particular the measures in relation to hydro-morphological pressures (not sufficiently addressed in the 1st RBMPs). Some measures require further technical specification in order to estimate their costs properly (e.g. the measures on retention and sedimentation ponds, environment friendly management of drainage systems).

Filling the information gaps above would allow proper economic assessment and evaluation of measures (incl. assessing their cost-effectiveness), since even with qualitative and semi-quantitative evaluation approaches at least minimum information base with national estimates is needed.

4.4.4 Cost-effectiveness of measures

4.4.4.1 Definition of the criterion used in the study

The cost-effectiveness of a measure is commonly estimated by diving costs of a measure by its effect. It allows comparing various measures based on costs per one effect unit and selecting those that ensure the “least cost way” for achieving a specified environmental target.

As noted the cost-effectiveness was assessed by considering only the “targeted effect” of a measure and its ‘financial costs’ (see the chapters 4.4.2.2 and 4.4.3.2 for the assessments). A matrix as shown in the table below was used to derive the cost-effectiveness assessment for each measure from their effectiveness and costs’ scores.[16] The cost-effectiveness is also assessed by 5-category scale. The most cost-effective measures would have the score “5” (when the effectiveness is very high or high and the costs very low or low – the dark green cells in the table). The least cost-effective measures would have the score “1” (when the effectiveness is low or very low and the costs high or very high – the red cells in the table).

Table 4.6 Assessment of the cost-effectiveness as a matrix of cost scores and effectiveness scores. *(Source: ARCADIS (2012b)*

Cost scores	Effectiveness scores				
	5 very high	4 high	3 moderate	2 low	1 very low
1 very high	3	3	2	1	1
2 high	3	3	3	2	1
3 moderate	4	4	3	2	2
4 low	5	4	3	3	3
5 very low	5	5	4	3	3

[16] Such an approach has been used for the cost-effectiveness assessment of measures, for instance, in ARCADIS (2012) *“Pilot project ‘4 Seas’ – plastic recycling cycle and marine environmental impact. Case studies on the plastic cycle and its loopholes in the four European regional seas areas”*. Final report of a project for the EC (Project No BE011102328).

According to the matrix, the cost-effectiveness of a measure can be moderate for different reasons: 1) the effectiveness is high, but a measure is also very expensive, 2) the costs and effectiveness are both moderate and 3) a measure has low effectiveness, but at low costs. Even if these three groups have the same cost-effectiveness, the first group of measures could be preferred as it brings the intended change although at high cost.

4.4.4.2 Assessment of measures with the criterion

The cost-effectiveness was estimated separately for each water quality problem – the nutrients' pollution and the hydro-morphological alterations. The next table summarises the assessment scores of effectiveness, costs and cost-effectiveness for all measures reducing the nutrients' pollution pressure (only "technical" measures with direct effect are analysed).

Table 4.7 Assessment of the cost-effectiveness of measures for nutrients' pollution problem. *(Source: Based on the effectiveness and costs' assessments presented in the chapters 4.4.2.2 and 4.4.3.2.)*

Notes: "NK" – the assessment could not be developed due to lack of information.

[1] Categories for the effectiveness as presented in the chapter 4.4.2.2, categories of the costs as presented in the chapter 4.4.3.2, categories for the cost-effectiveness according to the matrix in the previous chapter.

[2] Effectiveness with regard to nutrients' pollution. It is marked with light blue colour when it is the "targeted effect" of a measure, otherwise it is due to multiple effects of a measure (see the chapter 4.6 for more information and the Annex 4 for the assessments concerning each water quality element).

[3] Assuming the "voluntary" width 5 or 10 m (depending on size of a WB) of the buffer zone. If the width is 3m only, the effectiveness is lower ("1" for N, "3" for P), thus also the CE is lower ("3" for N, "4-5" for P).

[4] The cost-effectiveness assuming no 'financial costs'. When accounting the 'economic costs' the CE would be lower for LV6.1 (4-5 for P, 2-3 for N) and for LV7 (4 instead of 5). See the chapter 4.7 for more information about assessment of the 'economic costs'.

Name of measure	Assessments (scores from 1-5 [1])				Comments
	Effective-ness [2]	(Financial) Costs	Cost-effectiveness (CE)		
LV1 Arranging environmentally safe manure storage facilities	5	1	3 (moderate)		Assuming isolated manure storage facilities (not storage on field).
LV2 Construction of biological WWTP in dairies	4	3/2	4 (high)	3 (moderate)	
LV3 Crop fertilisation planning	3	3	3 (moderate)		Taking into account the initial specification of the M. in the ECOLAS model.
LV4 Winter green areas and stubble fields	4	3	4 (high)		
LV5 Green manure	3	1	2 (low)		
LV6.1 Agricultural land buffer zones for water courses and bodies	1 or 3 for N, 4 or 5 for P [3]	NK / (-?)	NK /		The CE assuming no 'financial costs' (FC) like assumed in the 1st RBMPs (ECOLAS model). However, the M. could involve also the FC. Could not be assessed due to lack of information.
			3 or 5 for N [3], [4]	5 for P [3], [4]	
LV6.2 Agricultural land buffer zones for drainage systems	1	NK / (-?)	NK	3 (moderate) [4]	
LV7 Good felling practice	4	NK / (-?)	NK	5 (very high) [4]	

Name of measure	Assessments (scores from 1-5 [1])				Comments
	Effective-ness [2]	(Financial) Costs	Cost-effectiveness (CE)		
LV8 Forest buffer zones	3	-	4 (high)	5 (very high)	No 'financial costs' (only 'economic costs' assumed).
LV11 (AD) Nutrients' retention ponds in AGR drainage systems	2 for N, 4 for P	1	1 for N	3 for P	
LV12 (AD) Sedimentation ponds to reduce impact of soil erosion from FOR activities	3	5	4		
LV13 (AD) Sedimentation ponds to reduce impact of soil erosion from AGR lands	3	5	4		
LV14 (AD) Sedimentation ponds as part of environment friendly management of FOR drainage systems	3	5/4	4 (high)	3 (moderate)	
LV15 Improving ecological functionality of lakes	2-5 (as interval)	NK	NK		The effectiveness is very case specific.
LV20 Environment friendly management of FOR drainage systems (LV20.2]	3 or 1	NK	NK		3 if beaver caused problems exist, 1 otherwise (if only Act.1 of the M. is needed).
LV21 Environment friendly management of AGR drainage systems [LV21.2]	3	NK	NK		
LV22 Environment friendly management of polder systems	NK	NK	NK		Actual measures are not specified yet.
LV 26 (AD) Improving ecological processes when maintaining regulations of rivers	3	NK	NK		
LV27 (AD) Improving ecological functionality of regulated rivers by naturalisation of river bed	3	NK	NK		
LV28 (AD) Management of Protected Belts of water courses/bodies	5	NK	NK		The efficiency assessment is valid for cases with the water quality problems caused by lack of maintenance of the Protected Belts.

As can be seen from the table, the cost-effectiveness could not be assessed for half of the measures, which is due to lack information. For the measures LV6.1, LV6.2 and LV7 it is assessed assuming no 'financial costs' (as it was assumed for the 1st RBMPs). However the measures might create the 'financial costs', and, accordingly, the cost-effectiveness might be lower.

There are no 'financial costs' for the measure LV8 ("Forest buffer zones"). But taking the 'economic costs' into account the cost-effectiveness would be lower than shown in the table ("high to moderate" instead of "very high to high"). Lower cost-effectiveness could be seen for other measures also when taking into account the 'economic costs'. More information about the

assessment of the 'economic costs' is provided in the chapter 4.7, and about the evaluation of measures considering all types of the costs in the section 5.

From those measures were the assessments are derived, the highest cost-effectiveness is for the LV4 "Winter green areas and stubble fields" due to relatively high effectiveness and moderate costs, LV8 "Forest buffer zones" since it doesn't create 'financial costs' and sedimentation ponds (LV12 and LV13) due to very low 'financial costs' even with moderate only effectiveness. Reducing nutrients' pollution is not the "target effect" of the sedimentation ponds, but they are cost-effective for this also due to the very low costs. Even without knowing the 'financial costs', the measure LV7 "Good felling practice" seems to be highly cost-effective, as well as LV6.1 "Agricultural land buffer zones for water courses and bodies" (although it depends on width), in particular for N reduction.

The nutrients' retention ponds (LV11) have moderate cost-effectiveness for P reduction, but very low for N reduction due to the high costs. LV5 "Green manure" is the other least cost-effective measure.

It should be stressed that certainty of the effectiveness and costs' assessments is not discussed at this stage – it is analysed under the separate criterion C7 (see the chapter 4.10).

The next table list the measures that can affect the hydro-morphological water quality elements (hydrological regime, continuity, morphology). 15 measures from the analysed have such effect (either by the "targeted effect" or by the multiple effects of a measure). Practically all the measures (14) can affect morphology (e.g. sediment structure, structure of banks). But only 6 measures can affect hydrological regime and only 4 measures continuity. Scores and colours in the cells show the cost-effectiveness of the measures where it could be estimated (otherwise not estimated due to lack of information on the 'financial costs').

Table 4.8 Measures for hydro-morphological quality problems and their assessed cost-effectiveness. *(Source: Based on various information sources, the assessment developed by the project's experts.)*

Notes: Only those measures that can affect any of the hydro-morphological quality elements are included in the table. "X" marks cases where a measure can affect the water quality element but the cost-effectiveness could not be assessed due to lack of information. "NK" marks a case where the impact in terms of specific water quality elements is unknown. The cost-effectiveness is assessed (where possible) with the same (5-category) scale and approach as for the nutrients' pollution problem. The text in brackets for the effect/effectiveness shows activity addressed by a measure (can be agriculture (AGR), forestry (FOR) or other (OTH)).

[1] The measures might create 'financial costs', but they couldn't be assessed due to information gaps. The cost-effectiveness is estimates assuming no such costs. When it is estimated taking into account the 'economic costs' of the measures, it would be lower for LV6.1 (4 instead of 5), and LV7 (3 instead of 4).

[2] The measure doesn't create 'financial costs'. When the cost-effectiveness is estimated taking into account the 'economic costs', it has the score "5-4" (very high to high).

Name of measures	Hydro-morphological water quality elements:		
	Hydrological regime	Continuity	Morphology (sediments)
LV6.1 Agricultural land buffer zones for water courses and bodies			5 (very high) [1] (AGR)
LV6.2 Agricultural land buffer zones for drainage systems			5 (very high) [1] (AGR)
LV7 Good felling practice			4 (high) [1] (FOR)
LV8 Forest buffer zones			5 (very high) [2] (FOR)

Name of measures	Hydro-morphological water quality elements:		
	Hydrological regime	Continuity	Morphology (sediments)
LV11 (AD) Nutrients' retention ponds in AGR drainage systems			2 (low) (AGR)
LV12 (AD) Sedimentation ponds to reduce impact of soil erosion from FOR activities			5 (very high) (FOR)
LV13 (AD) Sedimentation ponds to reduce impact of soil erosion from AGR lands			5 (very high) (AGR)
LV14 (AD) Sedimentation ponds as part of environment friendly management of FOR drainage systems			5 (very high) (FOR)
LV15 Improving ecological functionality of lakes	X (OTH)		X (OTH)
LV20 Environment friendly management of FOR drainage systems [LV20.2]	X (FOR)	X (FOR)	X (FOR)
LV21 Environment friendly management of AGR drainage systems [LV21.2]	X (AGR)		X (AGR)
LV22 Environment friendly management of polder systems	NK (AGR)	NK (AGR)	NK (AGR)
LV 26 (AD) Improving ecological processes when maintaining regulations of rivers	X (AGR)	X (AGR)	X (AGR)
LV27 (AD) Improving ecological functionality of regulated rivers by naturalisation of river bed	X (AGR)	X (AGR)	X (AGR)
LV28 (AD) Management of Protected Belts of water courses/bodies	X (OTH)	X (OTH)	X (OTH)
No of measures addressing problems for the water quality element:	***6***	***4***	***14***
With AGR as the source of problem:	*3*	*2*	*7*
With FOR as the source of problem:	*1*	*1*	*5*
With OTHER source(s) of problem:	*2*	*1*	*2*

The results show that for the morphology, where many alternative measures are available, the sedimentation ponds are very highly cost-effective due to very high effectiveness and very low costs. But also buffer zones are very highly cost-effective due to the same reasons, in spite of the fact that this is not the "targeted effect" of these measures. The cost-effectiveness of many measures in relation to this quality element could not be estimated due to lack of information on the costs.

For the other two water quality elements, when looking the measures by the targeted activities (e.g. agriculture, forestry) rather few alternative options (measures) are available for addressing each activity (which needs to be taken into account when selecting measures on WB scale). All these measures have multiple effects in terms of various hydro-morphological quality elements. Their cost-effectiveness could not be estimated due to lack of information on the costs. This is important gap for future work.

4.5 Time until the effect after making a measure operational (C2)

The relevance assessment based on the inquiry of specialists is provided in the next table. This criterion received the lowest relevance score overall. Although it is marked among 5 the most important criteria in 2 cases (by environmental specialists/ scientists) and was assessed with the scores "4" or "5" in 4 cases out of all, the most frequently assigned score (Mode) is "1" (in 4 cases). This result indicates that relevance of the criterion is viewed differently. Due to limitation of the study the measures were not assessed using this criterion. It can be suggested overall that

the criterion should not be ignored, however simple approach to consider it in the evaluation of measures could be applied.

Table 4.9 Relevance assessment of the criterion based on results of the inquiry of specialists (2013).

Total number of responses – 12. The responses included assessment of each criterion by a scale from 1 "low relevance" to 5 "high relevance" and marking 5 the most important criteria from the listed (11 in total).

No of responses	12
SUM	33
Average	2,75
No of cases "among 5 the most important"	2
No of scores "4" and "5"	4
Mode (most frequently assigned score)	1
Median (middle of data row)	3
Range: Min/Max	1/5
No of scores "1" and "2"	5
Group	Criterion with differently viewed importance

4.6 Multiple effects of measures (C3)

4.6.1 Relevance of the criterion

The relevance assessment based on the inquiry of specialists is provided in the table below. It shows that this criterion is commonly highly scored and is ranked among 5 the most important criteria for evaluation and selection of measures (together with the measures' cost-effectiveness, socioeconomic benefits, acceptance by stakeholders and certainty in funding availability).

Table 4.10 Relevance assessment of the criterion based on results of the inquiry of specialists (2013).

Total number of responses – 12. The responses included assessment of each criterion by a scale from 1 "low relevance" to 5 "high relevance" and marking 5 the most important criteria from the listed (11 in total).

No of responses	12
SUM	49
Average	4.1
No of cases "among 5 the most important"	8
No of scores "4" and "5"	9
Mode (most frequently assigned score)	5
Median (middle of data row)	4
Range: Min/Max	2/5
No of scores "1" and "2"	1
Group	Criterion of highest priority

4.6.2 Definition of the criterion used in the study

In this study the multiple effects exist if a measure impacts various WFD water quality elements (see the chapter 4.4.2 for the list of water quality elements used in the study). It is accounted if a measure improves state in relation to more than one water quality element.

Biological quality elements are impacted always to certain extent – by any measures with positive effect in terms of reducing pressure(s) or improving the state. But, as noted earlier, the measures are commonly identified to address specific pressures and they impact directly certain physicochemical and/or hydro-morphological quality elements. The latter are accounted when assessing the multiple effects.

For instance, buffer zones aim to reduce nutrients' pollution load, which is seen as the "targeted effect" ("nutrients" from the group of "chemical and physicochemical elements"), but also:

- improves oxygen saturation and thermal conditions in a WB ("other elements" from the group of "chemical and physicochemical elements");
- reduces soil erosion caused sediment transport to a WB ("morphology" from the group of "hydro-morphological elements).

Impacts on these other elements are accounted as the multiple effects.

4.6.3 Assessment of measures using the criterion

The collected information with quantitative estimates on effects of measures was used as input for developing the assessment. The assessment was developed based on expert judgement (by the project's experts). First of all, the effect of each measure on each water quality element was assessed using the scale from "1" meaning "very low load reduction efficiency" to "5" meaning "very high load reduction efficiency" (see the Annex 4 for these assessments). Afterwards a summary assessment on the multiple effects was developed for each measure. The result is provided in the next table.

The multiple effects were assessed with the scale from "1" (low multiple effects) to "5" (high multiple effects), where the scale was specified in the following way:

- "1" when only element(s) from the same group of the "targeted" water quality element[17] are impacted (e.g. the group of "chemical and physicochemical" or "hydro-morphological" quality elements depending on a measure);
- "2" when also at least 1 element from the other group of quality elements is impacted;
- "3" when at least 2 elements of the other group are impacted;
- "4" when at least 3 elements of the other group are impacted;
- an additional 1 point is accounted for the scores "2", "3" or "4" when the impact on element(s) of the other group is high (a measure gives high (>3) load reduction efficiency for these elements).

The assessment shows that high multiple effects are created by the measures LV26-28, sedimentation ponds (LV12-14), LV15 and LV21. Buffer zones, LV8 "Good felling practice" and nutrients' retention ponds (LV11) have moderate multiple effects. The measures LV1-LV5 have impact on physicochemical quality elements only, thus, low multiple effects.

[17] See the chapter 4.4.2 for more information with regards to the "targeted effect".

Table 4.11 Assessment of the multiple effects of the measures. *(Source: Various information sources, the assessment developed by the project's experts.)*

Notes: Assessment with 5-category scale from 1 "low" to 5 "high" multiple effects. "-" a measure has no direct impact on reducing pressure/improving state. "NK" effect could not be assessed due to lack of information.

* Retention ponds are targeted to nutrients. Their "secondary" effect – on hydrology (accumulation of sediments) is relatively lower. Sedimentation ponds are targeted to sediments (morphology). But they give as large positive "secondary" effect for nutrients' accumulation (together with soil particles). Thus their multiple effects are seen higher comparing to the retention ponds.

** "4" in cases of beaver caused problems, "3" without beaver caused problems. If the beaver caused problems exist they affect significantly many water quality elements. If this is the case, the measure (its Activity 2, see the description) eliminates the negative consequences resulting in considerable improvement.

Name of measure	Assessment	Name of measure	Assessment
LV1 Arranging environmentally safe manure storage facilities	**1**	LV15 Improving ecological functionality of lakes	**4**
LV2 Construction of biological WWTP in dairies	**1**	LV16 Investigation about measures for regulated rivers	**-**
LV3 Crop fertilisation planning	**1**	LV17 Development of technical provisions for FOR drainage systems	**-**
LV4 Winter green areas and stubble fields	**1**	LV18 Development of technical provisions for AGR drainage systems	**-**
LV5 Green manure	**1**	LV19 Development of technical provisions for polders	**-**
Agricultural land buffer zones for LV6.1 water courses and bodies LV6.2 drainage systems	**3** **3**	LV20 Environment friendly management of FOR drainage systems (LV20.2)	**3 or 4 ****
LV7 Good felling practice	**3**	LV21 Environment friendly management of AGR drainage systems (LV21.1 and 21.2)	**4**
LV8 Forest buffer zones	**3**	LV22 Environment friendly management of polder systems	**NK**
LV9 Proposals to reduce impact of agricultural activities	**-**	LV23 Development of RB Management Information system	**-**
LV10 Research and proposals for lakes with unknown reason "at risk"	**-**	LV24 Educational and Informational measures	**-**
LV11 (AD) Nutrients' retention ponds in AGR drainage systems	**3 ***	LV25 Organising public participation	**-**
LV12 (AD) Sedimentation ponds to reduce impact of soil erosion from FOR activities	**4 ***	LV26 (AD) Improving ecological processes when maintaining regulations of rivers	**4**
LV13 (AD) Sedimentation ponds to reduce impact of soil erosion from AGR land	**4 ***	LV27 (AD) Improving ecological functionality of regulated rivers by naturalisation of river bed	**4**
LV14 (AD) Sedimentation ponds as part of environment friendly management of FOR drainage systems	**4 ***	LV28 (AD) Management of Protected belts of water courses/bodies	**5**

4.6.4 Relevant gaps for future work

Since the assessment of the multiple effects builds on individual effectiveness assessments in relation to each water quality element for each measure, the same information gaps as noted for the effectiveness' assessment are important also here – see the chapter 4.4.2.3 for more information.

4.7 Economic costs of measures (C4)

4.7.1 Relevance of the criterion

The relevance assessment based on the inquiry of specialists is provided in the table below. It shows that this criterion is commonly scored as important.

Table 4.12 Relevance assessment of the criterion based on results of the inquiry of specialists (2013).

Total number of responses – 12. The responses included assessment of each criterion by a scale from 1 "low relevance" to 5 "high relevance" and marking 5 the most important criteria from the listed (11 in total).

No of responses	12
SUM	43
Average	3.6
No of cases "among 5 the most important"	2
No of scores "4" and "5"	5
Mode (most frequently assigned score)	3
Median (middle of data row)	3
Range: Min/Max	2/5
No of scores "1" and "2"	1
Group	Important criterion

4.7.2 Definition of the criterion used in the study

Economic costs are foregone gains that come from value of an alternative that is foregone due to implementing a measure, for instance, foregone income due to yield loss when converting arable land to other land use type (e.g. buffer zone). The economic costs (like the 'financial costs' of a measure) are direct costs caused by implementing the measure to those who implement it (unlike wider economic impacts that concern other sectors/societal groups).

It should be note that specific measures may create also direct economic gains (e.g. saved costs on fertilisers thanks to more efficient fertilisation planning and application). Both the economic costs and gains are considered under this criterion in this study.

4.7.3 Assessment of measures using the criterion

To our knowledge this is the first attempt to review the 'economic costs' (and gains) of the WFD 'supplementary' measures for Latvia in a systematic manner for all measures. There is previous information about the 'economic costs' for few measures, in particular, buffer zones (e.g. the assessments developed for the 1st RBMPs). In the 1st programs of measures they are accounted by the ECOLAS model for part of the 'supplementary' measures that relate to agriculture and forestry. Besides the model overall includes limited list of the measures.

The assessment for each measure was developed based on review of literature and expert knowledge. Like for other criteria, 5-category scale was used. To account positive and negative economic effects (costs and gains) the scale was:

- for the 'economic costs – 'from "1" meaning "very high" to "5" meaning "very low",
- for the 'economic gains' – from "1" meaning "very low" to "5" meaning "very high".

All positive and negative direct economic effects (costs and gains) are considered as far as noted in literature and by expert knowledge. Thus the review aims to be complete in terms of types of the effects that come from the analysed measures.[18] But the assessments could be provided for part of the measures only (in particular, concerning the gains), besides they are rather rough and uncertain. Information base is not sufficient to develop reliable assessments for all the measures.

To account magnitude of the costs and gains in the assessment it was considered how large production land area would be affected by the negative/positive impact creating economic costs/gains when implementing a measure. For instance, only area of establishing buffer zone/pond/bordering water course or larger production land area. Magnitude of the impact on yield was also considered. For instance, if the harvest is lost fully in application area of a measure (e.g. in case of buffer zones/ponds) or only may get reduced, or to what extent the yield may get increased or production costs saved in the case of gains. It should be noted that a special (quantitative) analysis was not conducted to evaluate the impacts of the measures in light of these issues. Such analysis would require a special study (or even studies, taking into account variety of the measures). However these issues were kept in mind when developing the assessments based on the expert judgement. The developed assessments are summarised in the next table.

[18] It should be noted that:

- Concerning the economic costs, 'opportunity costs of investments' (foregone gains from using the money in an alternative way) are not accounted. They arise from all measures in principle. Although for some measures with larger initial investments (e.g. building manure storage facility or biological WWTP in dairy) they might be seen as more important.
- The economic gains do not account potential income of farmers/forest owners from environmental subsidies for implementing measures since this is money transfer, which just transfers the costs of implementing the measures to other groups of society.

Table 4.13 Assessment of the 'economic costs' and 'economic gains' of implementing the measures. *(Source: Various information sources, the assessments developed by the project's experts.)*

Notes: "NK" refers to cases where the economic costs/gains could not be assessed due to lack of information. Only those measures are included in the table, where the economic costs and/or gains are expected (no such costs/gains can be assumed for other analysed measures).

(*) The gains come from "value of information" for decision-making. Improved information (from research-type measures) allows setting appropriate measures and their location and to avoid "wrongly" set "technical" measures. Since the measures involve costs to sectors, the improved information allows avoiding unnecessary costs (of "wrong" measures).

	Economic COSTS (EC)		**Economic GAINS (EG)**	
Name of measure	**Assessment**	**Explanation**	**Assessment**	**Explanation**
LV3 Crop fertilisation planning			2 (low) / NK	Costs' saving from lower fertilisers' use thanks to more effective fertiliser planning and application. Magnitude of gains depends on the current fertilisation level. In countries with intensive fertilisers' use (higher over-fertilisation) the gains are important. But there is no information how far it is the case of Latvia.
LV4 Winter green areas and stubble fields	5 (very low) / NK	A late destruction of crops used as plant cover may cause bolting and increased parasitic burden. Moreover the mechanical destruction of crops by grinding or tillage can promote the proliferation of limaces. This can increase need for use of pesticides. In structural damages etc. there may also be costs related to reductions in yield in the main crops.	1 / 2 (very low or low)	Potential costs' saving from lower need for purchased fertilizers. It may occur due to decreased soil erosion (thus fixing nutrients in soil) and, in particular, if the winter cover consists of green manure (catch) crops. Gains may occur in case the winter plants are harvested (e.g. if the winter cover consists of winter cereals). Although the costs for harvesting need to be accounted then.
LV5 Green manure			2 (low)	Costs' saving from lower need for purchased fertilizers. Increased yield due to positive effect of the green manure on soil structure, organic content of soil, less erosion, etc.
LV6 Agricultural land buffer zones for LV6.1 water courses and bodies	3 (moderate)	The EC primarily comprise the lost production on buffer zone area (foregone income due to yield loss). Although could be other types of the costs also. The assessment assumes 5/10 m width. In the 1st RBMPs this is accounted and have been estimated quantitatively (under yearly (O&M) costs since occur every year).	1 (very low)	Increased yield from improved soil quality due to reduced water erosion of soil in arable land areas bordering water courses/drainage ditches. Potential income if harvesting biomass from buffer zone.
LV6.2 drainage systems	4 (low)	Foregone income due to yield losses in buffer zone areas (2 m width). Such M. was not clearly specified in the 1st PoM.		

	Economic COSTS (EC)		Economic GAINS (EG)	
Name of measure	**Assessment**	**Explanation**	**Assessment**	**Explanation**
LV7 Good felling practice	3 (moderate)	Foregone income (harvested timber) since the M. requires leaving non-felled trees in the felling area. In the 1st RBMPs this is accounted and have been estimated quantitatively (under "investment costs" since occur once in 15 years – cycle of clear-cutting) – 10 % less felling is assumed.		
LV8 Forest buffer zones	5 / 4 (very low or low)	Foregone income (harvested timber) since the M. requires leaving greater tree density in the buffer zone. The M. has the EC only (no financial costs). In the 1st RBMPs, this is accounted (under "investment costs" since occur once in 15 years – cycle of clear-cutting).	1 / 0 (very low or no gains)	EG from improved soil quality in lands bordering water courses due to reduced water erosion of soil.
LV9 Proposals to reduce impact of agricultural activities			2 (low)	(*) Improved information for decision-making (on appropriate measures and their location) => avoided costs of unnecessary ("wrong") measures.
LV10 Research and proposals for lakes with unknown reason "at risk"			3 (moderate)	
LV11 (AD) Nutrients' retention ponds in AGR drainage systems	4 (low)	Foregone income due to yield loss from the area that is used for the retention pond/wetland.	0 (no gains)	Literature refers to wetlands noting that economic income from them is often zero unless it is utilized, e.g., for farm tourism or grazing. Since the proposed measure is seen more as pond than wetland, no gains were assumed.
LV12 (AD) Sedimentation ponds to reduce impact of soil erosion from FOR activities	5 / 0 (very low or no)	Foregone income due to yield loss from the area that is used for pond.	1 (very low) / NK	EG from reducing impact of soil erosion on drainage systems, thus maintained functionality of the drainage systems and better regulation of soil moisture.
LV13 (AD) Sedimentation ponds to reduce impact of soil erosion from AGR lands	5 (very low)		1 (very low) / NK	
LV14 (AD) Sedimentation ponds as part of environment friendly management of FOR drainage systems	5 / 0 (very low or no)		1 (very low) / NK	
LV16 Investigation about measures for regulated rivers			1 (very low)	(*) Improved information for decision-making => avoided costs of "wrong" measures.
LV20 Environment friendly management of FOR drainage systems (LV20.2)			1 / 0 (very low or no gains) / NK	EG from maintained functionality (designed run-off capacity) of drainage system.

	Economic COSTS (EC)		Economic GAINS (EG)	
Name of measure	**Assessment**	**Explanation**	**Assessment**	**Explanation**
LV21 Environment friendly management of AGR drainage systems (LV21.1 and LV21.2)	4 (low)	(For LV21.1) Foregone income due to yield loss from the area that is used for the retention pond/wetland. (The same as for LV11.)	1 (very low) / NK	EG from improved soil quality in lands bordering water courses due to reduced water erosion of soil and from maintained functionality of drainage system.
LV22 Environment friendly management of polder systems	NK	Actual measures are not specified yet.	NK	Actual measures are not specified yet.
LV26 (AD) Improving ecological processes when maintaining regulations of rivers			1 (very low) / NK	EG from improved soil quality in lands bordering water courses due to reduced water erosion of soil and from maintained functionality of drainage system.
LV27 (AD) Improving ecological functionality of regulated rivers by naturalisation of river bed			NK	The M. involves also rehabilitation of naturally degraded banks and management of bank stability and water erosion. EG from improved soil quality in lands bordering river due to reduced water erosion of soil.
LV28 (AD) Management of Protected belts of water courses/bodies			NK	EG from improved soil quality in lands bordering water courses due to reduced water erosion of soil.

4.7.4 Relevant gaps for future work

The **lack of information on the 'economic costs and gains' of the measures** doesn't allow developing reliable assessments on magnitude of these impacts. The assessments were developed purely on experts' knowledge. Due to the lack of information they are very rough and uncertain. For part of the measures they could not be provided at all. Thus it is not possible currently to apply the given criterion for the evaluation of measures with sufficient reliability.

It should be noted that the 'economic costs' have been accounted in the 1st RBMPs where relevant for those nutrients' pollution reduction measures that have been clearly specified in the programs of measures (e.g. LV6-8)[19]. However, it can be seen that the 'economic costs' could be relevant also for some newly specified and added measures (e.g. ponds). The 'economic gains' have not been accounted in the 1st RBMPs. They can be expected for some measures included in the 1st programs of measures, and they may occur also from part of newly specified and added measures.

Experience from the 1st cycle (e.g. with the buffer zones) indicates that considerable 'economic costs', which are not accounted sufficiently, may hinder implementation of measures. **Quantitative estimates of the 'economic costs'** should be developed for the measures where they are considerable, in particular for those measures without or limited 'financial costs'. Otherwise the direct costs of such measures are underestimated in the economic evaluation of measures. Such estimates would allow reliable assessment with the given (semi-quantitative) approach, but would be important also for estimating total costs of measures for the programs of measures.

There are various factors that determine size of the 'economic costs'. They mainly comprise lost production on the measures' application areas (buffer zones, sedimentation/retention ponds). The foregone income due to yield loss first of all depends on size of lost production land area. This requires investigating application area of a measure as share of production land area (e.g. arable land in case of agricultural buffer zones or ponds). This can be done based on GIS data (was not done for the 1st RBMPs, where an assumption was used). In addition, the foregone income depends on type of grain, yields and prices. Approach used for the 1st RBMPs, when the 'economic costs' of forest buffer zones are estimated based on lost production land (cadastral) value, gives rather rough estimate. For the agricultural buffer zones, the 'economic costs' have been estimated in 2007-2008. These estimates should be updated since the economic variables (e.g. grain type, prices) change over time.

Concerning the 'economic gains', the information base should be improved for assessing certainty of occurrence the gains (from implementing a measure). It should be done for the measures with possible gains indicated by this study (in particularly, with the assessment "NK"). It is little likely that the gains could be quantified for all measures, but the **magnitude of the impact could be investigated at least up to extent that reliable semi-quantitative assessment could be developed**. This would allow taking them into account in the economic evaluation of measures.

[19] Although shortcomings should be noted in these estimates. For instance, for the forest buffer zones the costs have been estimated based on value of lost production land (based on the land cadastral value). This can be seen as rough estimates since the actual 'economic costs' depend on yield, prices etc. An assumption is used in the CEA model concerning the size of lost production land area (arable land and forest land) due to the buffer zones, which has not been verified with the national data.

4.8 Administrative costs of implementing measures (C5)

4.8.1 Relevance of the criterion

The relevance assessment based on the inquiry of specialists is provided in the table below. This criterion has received relatively lower average score, besides the individual assessments of its importance were quite opposite. The differences in individual assessments might be explained by the fact that this type of costs are usually borne to specific actors (concerned by the administrative actions e.g. monitoring, control, enforcement) thus they could be seen as more important by those who are affected. Another reason could be also that there might be limited awareness on the magnitude of these costs since they are sometimes "hidden" in the current budgets/responsibilities of the concerned institutions. The result indicates that the criterion should not be ignored, but a simplified approach on how to consider it in the evaluation of measures should be found.

Table 4.14 Relevance assessment of the criterion based on results of the inquiry of specialists (2013).

Total number of responses – 12. The responses included assessment of each criterion by a scale from 1 "low relevance" to 5 "high relevance" and marking 5 the most important criteria from the listed (11 in total).

No of responses	12
SUM	37
Average	3.1
No of cases "among 5 the most important"	3
No of scores "4" and "5"	5
Mode (most frequently assigned score)	5
Median (middle of data row)	3
Range: Min/Max	1/5
No of scores "1" and "2"	5
Group	Criterion with differently viewed importance

4.8.2 Definition of the criterion used in the study

The 'administrative costs' are defined in this study as costs of administrative actions/measures that in general don't lead directly to reducing pressures or improving the state. Such actions/measures may include:

1. preparing and passing through national regulations, guidelines, environmental/ technical standards;
2. actions for implementation of regulatory measures (e.g. permits), enforcement and controlling actions (e.g. inspections) for implementation of the measures;
3. public information (incl. advisory services) and involvement;
4. research, modelling etc.;
5. planning (e.g. development of plans) and coordination of the policy;
6. environmental monitoring of water bodies;
7. reporting.

The 'administrative costs' are viewed in light of evaluation of measures (not as the administrative costs of the WFD generally). Some of the cost types above are not related directly to measures

(e.g. monitoring and reporting). Only those types of the costs that are created due to the measures (specific for each measure) are taken into account (the type 1-5 above).

It should be noted also that only the additional costs created by the WFD measures should be accounted. In some cases it could be difficult to separate them from the administrative costs of the current policies' measures. For instance, enforcement, controlling, public information costs for the agricultural measures that are both 'basic' and 'supplementary' measures of the WFD (although with different application terms and areas).[20]

4.8.3 Assessment of measures using the criterion

No studies have been conducted in Latvia so far on estimating administrative costs of the WFD measures (nor the WFD overall). The lack of information didn't allow developing even qualitative assessments of magnitude of such costs.

At the same time, the relevance assessment of the criterion suggests that a simplified approach could be followed for assessing these costs (instead of putting extensive work for their quantitative estimation for all measures). The first qualitative review of types and presence of such costs was conducted as part of this study. It was done based on the project's expert knowledge. It aimed to indicate measures where these costs could be considerable and should be assessed more profoundly if this criterion wants to be taken into account in the evaluation of measures.

The results are provided in the following table. The 'administrative costs' for each measure were reviewed by the types of actions as indicated above (the type 1-5). The presence of the costs is indicated for each measure with regards to each type. The measures with potentially considerable administrative costs are highlighted.

It should be noted that the review didn't consider potential impact of budgetary constraints. The size of (and required increase in) administrative costs often is constrained in reality by available manpower and budget of responsible institutions, in particular in tight budgetary situation as it is in Latvia.

[20] Such measures in Latvia are "arranging environmental safe manure storage facilities", "crop fertilisation planning" and "winter green areas".

Table 4.15 Review on the 'administrative costs' (AC) of the measures. *(Source: Based on the project's expert knowledge.)*

Notes: "+" indicates presence of the 'administrative costs'.

The 'administrative costs' may be considerable.

Types of actions creating AC Measures (M)	Regulations [1]	Implemen-tation [2]	Public information [3]	Research [4]	Planning [5]	General comments on the 'administrative costs' (AC)
LV1 Arranging environmentally safe manure storage facilities	+ (For public funding)	+ (!) (Control.)	- (Known M. Small applic.)	-	+ (Coordin.)	(!) Controlling costs may be considerable and the controlling institutions are facing budgetary constraints. Since the measures are proposed for small areas (few selected WBs) => AC low. With larger application of measures => Controlling costs might be seen as important.
LV2 Construction of biological WWTP in dairies	+ (For public funding)	+ (!) (Control.)	- (Small applic.)	-	+ (Coordin.)	
LV3 Crop fertilisation planning	-	+ (!) (Control.)	+ (Advisory Serv.)	-	+ (Coordin.)	
LV4 Winter green areas and stubble fields	-	+ (!) (Control.)	+ (Inform. Advis.?)	-	+ (Coordin.)	
LV5 Green manure	-	+ (!) (Control.)	+ (Inform.)	-	+ (Coordin.)	
LV6 Agricultural land buffer zones for LV6.1 water courses and bodies LV6.2 drainage systems	+ (For public funding)	+ (!) (Control.)	+ (Inform.)	+? (GIS)	+ (Coordin.)	Although the M. is known overall, all costs' types.
LV7 Good felling practice	? (For public funding)	+ (!) (Control.)	++ (Inform. Advis.?)	-	+ (Coordin.)	Relatively new M. Not familiar to concerned actors (need for public information). All costs' types.
LV8 Forest buffer zones	+ (For public funding)	+ (!) (Control.)	++ (Inform.)	? (GIS)	+ (Coordin.)	
LV9 Proposals to reduce impact of agricultural activities	-	-	-	+	+ (Planning follow up M, Coordin.)	(All costs of the M are attributed to AC.)
LV10 Research and proposals for lakes with unknown reason "at risk"	-	-	-	++	+ Planning follow up M)	Relatively high research costs. (All costs of the M are attributed to AC.)

Types of actions creating AC Measures (M)	Regulations [1]	Implemen-tation [2]	Public information [3]	Research [4]	Planning [5]	General comments on the administrative costs (AC)
LV11 (AD) Nutrients' retention ponds in AGR drainage systems	+ (For publ. funding. Permitting)	+	++	+? (GIS)	+ (Coordin.)	New M. Not familiar to concerned actors (need for public information). All costs' types.
LV12 (AD) Sedimentations ponds to reduce impact of soil erosion from FOR activities	+ (For publ. funding. Permitting)	+	++	-	+ (Coordin.)	
LV13 (AD) Sedimentations ponds to reduce impact of soil erosion from AGR land	+ (For publ. funding. Permitting)	+	++	+? (GIS)	+ (Coordin.)	
LV14 (AD) Sedimentation ponds as part of environment friendly management of FOR drainage systems	+ (For publ. funding. Permitting)	+	++	-	+ (Coordin.)	All costs' types. (AC viewed together with "technical provisions", e.g. LV14+LV17.)
LV15 Improving ecological functionality of lakes	+	-	++	-	+ (Coordin.)	
LV16 Investigation about measures for regulated rivers	+	-	- (under LV26 and LV27)	+ (Research)	+ Planning follow up M)	(All costs of the M are attributed to AC.)
LV17 Development of technical provisions for FOR drainage systems	+	-	- (under LV20)	-	+ (Coordin.)	(All costs of the M are attributed to AC.)
LV18 Development of technical provisions for AGR drainage systems	+	-	- (under LV21)	-	+ (Coordin.)	(All costs of the M are attributed to AC.)
LV19 Development of technical provisions for polders	+	-	- (under LV22)	-	+ (Coordin.)	(All costs of the M are attributed to AC.)
LV20 Environment friendly management of FOR drainage systems	+ (For publ. funding. Permitting)	+	++	-	+ (Coordin.)	New M. Not familiar to concerned actors (need for public information). All costs' types. (AC viewed together with "technical provisions", e.g. LV17+LV20, LV18+LV21, LV19+LV22.)
LV21 Environment friendly management of AGR drainage systems	+ (For publ. funding. Permitting)	+	++	-	+ (Coordin.)	
LV22 Environment friendly management of polder systems	+ (For publ. funding. Permitting)	+	++	-	+ (Coordin.)	

Types of actions creating AC Measures (M)	Regulations	Implemen-tation	Public information	Research	Planning	General comments on the administrative costs (AC)
	[1]	[2]	[3]	[4]	[5]	
LV23 Development of RB Management Information system	-	-	+	++	++	(All costs of the M are attributed to AC.)
LV24 Educational and Informational measures	-	-	+	-	-	(All costs of the M are attributed to AC.)
LV25 Organising public participation	-	-	+	-	+	(All costs of the M are attributed to AC.)
LV26 (AD) Improving ecological processes when maintaining regulations of rivers	- (under LV16)	+	++ (Inform. Advis.)	-	+ (Coordin.)	New M. Not familiar to concerned actors (need for public information). All costs' types. (AC viewed together with "investigation and proposal" LV16.)
LV27 (AD) Improving ecological functionality of regulated rivers by naturalisation of river bed	- (under LV16)	-	++ (Inform. Advis.)	+	+ (Planning site-specific M, Coordin.)	
LV28 (AD) Management of Protected belts of water courses/bodies	+	+	++ (Inform. Advis.)	-	+ (Coordin.)	New M. Not familiar to concerned actors (need for public information). All costs' types.

4.8.4 Relevant gaps for future work

The **lack of information on the 'administrative costs' of the measures** doesn't allow developing even qualitative assessment on magnitude of these costs. Thus it is not possible currently to apply the given criterion for the evaluation of measures. Although the criterion is not seen among the priority ones, improving information base on these costs would be needed in the future. There is little information on role of the administrative costs in efficiency of water policies' implementation. But it is increasingly recognised as important issue for developing efficient WFD programs of measures. Since high administrative costs, if not accounted, may hinder implementation of the measures. In particular, the following measures should be investigated in light of potentially important 'administrative costs':

- LV1-LV8 in light of the costs for enforcement and controlling of implementation of the measures. Since the measures are proposed for small areas (few WBs) in the Gauja RBD the costs couldn't be stated as high. But when application of the measures is accounted for the whole territory, the costs may be seen as important. In particular, since practice shows that responsible institutions are facing budgetary constraints.
- LV7 and LV8 are relatively new measures thus with high need for public information, although other administrative costs' types also need to be accounted.
- LV11-LV14, LV20-LV22, LV26-LV28 are new measures thus with high need for public information, although other costs' types also need to be accounted (e.g. regulatory, planning and coordination costs).

It should be noted that for the "research" and some "regulatory and administrative" measures direct (financial) costs are estimated for the 1st RBMPs (LV9, LV10, LV16-LV19), which are accounted as 'administrative costs' according to the approach in this study.

4.9 Indirect costs and wider negative socioeconomic impacts (C6)

4.9.1 Relevance of the criterion

The relevance assessment based on the inquiry of specialists is provided in the table below. It shows that this criterion is commonly scored as important.

Table 4.16 Relevance assessment of the criterion based on results of the inquiry of specialists (2013).

Total number of responses – 12. The responses included assessment of each criterion by a scale from 1 "low relevance" to 5 "high relevance" and marking 5 the most important criteria from the listed (11 in total).

No of responses	12
SUM	42
Average	3,5
No of cases "among 5 the most important"	4
No of scores "4" and "5"	5
Mode (most frequently assigned score)	3
Median (middle of data row)	3
Range: Min/Max	2/5
No of scores "1" and "2"	2
Group	Important criterion

4.9.2 Definition of the criterion used in the study

The indirect costs and wider negative socioeconomic impacts from implementing measures can be related to negative "secondary"/wider impacts on the sectors who implement measures[21] and the related sectors, distributional impacts in terms of geographical and social distribution of the costs[22] (e.g. impact on vulnerable groups of the society).

4.9.3 Assessment of measures using the criterion

The analysis included literature review to collect information on types of such possible negative impacts for various measures and identification of sectors/societal groups that could be affected by implementing each measure. The assessment was developed based on expert judgement. Several issues should be noted in relation to the assessment.

The impacts are characterised and assessed assuming implementation of the measures without public financial support in terms of compensations/subsidies to those who have to implement the measures (e.g. compensation for farmers for implementing buffer zones). It would make difference in the affected sectors in case when compensations/subsidies for implementing measures are applied, since the costs get transferred to society as a whole and the sector-related impacts get reduced. The public financial support is seen as important funding source for implementing many measures. But it is unclear for the next WFD cycle practically for all such measures.[23] The assessment here assumes the implementation without public financial support since it aims to highlight situations where policy actions would be needed (for instance, in terms of setting appropriate financing mechanisms/instruments to compensate significant negative impacts).

Cumulative socioeconomic impacts from applying several measures to the same sector/sub-sector are not accounted. They may arise when more than one measure is applied for the same sector/sub-sector (e.g. crop farming) in the same area. It can be seen from the 1st RBMPs that "technical measures" are even proposed in "sets" for certain areas. For instance, LV4, LV5 and LV6 (concerns crop farming), or LV7 and LV8 (concerns forestry) in specified WBs. Due to the aim and approach of this study each measure is evaluated separately. And it is recommended that the cumulative impacts are addressed as part of impact assessment of the overall program of measures (e.g. the "Strategic Impact Assessment").

Since the wider impacts of a measure commonly arise from the direct economic impacts (on those who need to implement a measure), magnitude of the wider impacts is linked to magnitude of the "direct" impact – on sector/actors implementing a measure. The assessment of direct impacts ('financial and economic costs') provided some information basis however more profound analysis for assessing the magnitude of the direct impacts would be needed.

Magnitude of the wider socioeconomic impacts depends on proposed application intensity of a measure (e.g. size of area where it is to be applied). Due to the aim and approach of this study to support more general evaluation and prioritisation of the measures (independently on specific application, e.g. in how many and which WBs), only general principles for the application are accounted. For instance, whether a measure is applied to the whole territory/wider areas or only to

[21] There can be also positive impacts from implementing the measures on those who implement them. If they are related to economic impacts on such a sector (e.g. costs' saving for a farm from lower need for purchased fertilisers) they are considered in this study as direct economic impacts – under the 'economic gains' (see the criterion 4, the chapter 4.7).

[22] The analysis of distribution of the impacts commonly aims to help structuring the stakeholder consultation process and identifying appropriate financing sources and mechanisms.

[23] See results for the C11 "Certainty in funding availability" in the chapter 4.14.

selected WBs failing GES.[24] The latter is the practice in the Latvian RBMPs concerning "technical" measures, including, for the agriculture and forestry. Consideration of the general principles of the application allows more realistic assessment of possible magnitude of the impacts, and also to identify possible negative distributional impacts.

Wider socioeconomic impacts can be regional or sector-specific, without necessarily resulting in national scale macro-economic impacts. Although negative effects can be created in individual sectors (e.g. through the closing of facilities and loss of jobs), these negative effects do not necessarily translate to macro-economic losses. For instance, it is possible that jobs lost are just transferred to another region or sector and, if this region or sector is not covered by this analysis, the benefit connected to the new jobs is also not covered. Such analysis of the "secondary" impacts of implementing the measures would be partial – regional or sector-specific and would not necessarily show the macro-economic impacts. The assessment here aims to look from the macro-economic perspective when considering possible magnitude of the impacts. However possible significant regional or sector-specific negative impacts (distributional impacts) of a measure are also highlighted.

The assessment is very rough due to lack of information in terms of national studies and data (evidence base) on such impacts of the WFD measures and limitations of this study. Wider consultations with experts and stakeholders from concerned sectors would be recommended to improve reliability of the assessment. The consultations would be helpful also to specify appropriate assessment categories. Due to limitations above, only use of a qualitative 3-category scale was possible (low/moderate/high possible negative impacts). But even such categories should be further specified to improve robustness of the assessment. For instance, at what level the impacts can be seen as "low" and at what – as "high", for various types of impacts.

The next table summarises the assessment results.

Table 4.17 Assessment of possible indirect costs and wider negative socioeconomic impacts associated with implementation of the measures. *(Source: Various information sources, the assessment developed by the project's experts.)*

Notes: Scale for the assessment: "low"/"moderate"/"high" possible negative impact. "DI" indicates considerable possible negative regional or sectoral impact (distributional impact).

Name of measure	Possible types of impacts and affected sectors/societal groups	Comments	Assessment
LV1 Arranging environmentally safe manure storage facilities	Due to additional costs' burden created by the M.: - Reduced profitability of livestock farming ⇨ **Livestock farms with 5-10 animal units**.[25] - Lost jobs due to reduced livestock farming activity (close down of individual farms) ⇨ Local communities. - Abandoned agricultural lands (if farming becomes economically infeasible) ⇨ Regional communities, society.	Assuming isolated manure storage facilities (not storage on field). The occurrence and magnitude of the wider impacts depend highly on the M. application intensity. With the given intensity (as proposed in the RBMPs), no considerable wider impacts should be expected. However impact on the concerned farms' group can be seen as considerable.	**Low** **DI**

[24] The specific application intensity can be considered in impact assessment of the overall program of measures, when impacts of the proposed program – with the specified application of measures, are analysed.

[25] The measure is applicable to farms with 5-10 livestock units (LU) outside the "Nitrate Vulnerable Zone" (NVZ) (since it is the 'basic' measure for farms with > 5 LU in the NVZ and for farms with > 10 LU in the whole territory of Latvia). The number of such farms could be in range of 10 % of all farms with livestock in Latvia, and only part of them is located outside NVZ. At the same time these are rather small farms facing larger economic and financial constraints.

Name of measure	Possible types of impacts and affected sectors/societal groups	Comments	Assessment
LV2 Construction of biological WWTP in dairies	Due to costs' burden created by the M.: - Reduced profitability of **dairy farming** ⇨ Dairy farming sector.[26] - More expensive milk products ⇨ Consumers, "linked" industries. - Lost jobs due to reduced dairy farming activity (close down of individual farms) ⇨ Local communities. - Abandoned agricultural lands (if farming becomes economically infeasible) ⇨ Regional communities, society.	The occurrence and magnitude of the wider impacts depend on the M. application intensity. With the given intensity (as proposed in the RBMPs), no considerable such impacts could be assumed. However impact on the concerned farms' group might be seen as considerable.	**Low-Moderate** **DI**
LV3 Crop fertilisation planning	1) Potential foregone income ⇨ Suppliers of fertilisers. 2) Due to costs' burden created by the M.: - Reduced profitability of **crop farming** ⇨ Crop farming sector, **on selected areas**. - More expensive crop products ⇨ Consumers, "linked" industries. - Lost jobs due to reduced crop farming activity (close down of individual farms) ⇨ Local communities. - Abandoned agricultural lands (if farming becomes economically infeasible) ⇨ Regional communities, society.	Possible magnitude of the 1st impact depends on how large reduction of purchased fertiliser use could be expected from implementing the M. There are no data for Latvia to what extent inefficient use of fertilisers ("over-fertilisation") is observed in practice that would be prevented by LV3. Also no assessments for the potential lower fertilisers' need from implementing LV4 and LV5. When the M. is proposed on limited areas (catchments of selected WBs), it creates unequal conditions for various actors of the same commercial sector.	**Low-Moderate** **DI**
LV4 Winter green areas and stubble fields			**Low-Moderate** **DI**
LV5 Green manure			**Low-Moderate** **DI**
LV6 Agricultural land buffer zones for LV6.1 water courses and bodies LV6.1 drainage systems	Due to economic burden created by the M. (yield loss in particular): - Reduced profitability of **crop farming** ⇨ Crop farming sector, **on selected areas.** - More expensive crop products ⇨ Consumers, "linked" industries. - Lost jobs due to reduced crop farming activity (close down of individual farms) ⇨ Local communities. - Abandoned agricultural lands (if farming becomes economically infeasible) ⇨ Regional communities, society.	The occurrence and magnitude of the wider impacts depend on intensity of the M. application. When the M. is proposed on limited areas (catchments of selected WBs), it creates unequal conditions for various actors of the same commercial sector.	**Low-Moderate** **DI**

[26] The measure is applicable to dairy farms with more than 230 dairy cows. Such farms make less than 1 % of all farms with dairy cows in Latvia (CSP, 2010). (It should be noted that almost 70 % of farms with dairy cows in Latvia are very small – with 1-5 dairy cows per farm.) At the same time, these are large farms that secure production for market. In terms of production output these farms could make more considerable proportion.

Name of measure	Possible types of impacts and affected sectors/societal groups	Comments	Assessment
LV7 Good felling practice	Due to economic burden created by the M. (in particular, wood harvest loss due to felling limitations): - Reduced profitability of **forestry activity** ⇨ Forestry sector, **on selected areas.** - More expensive wood products ⇨ Consumers, "linked" industries. - Lost jobs due to reduced forestry activity ⇨ Local communities.	The occurrence and magnitude of the wider impacts depend on intensity of the M. application. When the M. is proposed on limited areas (catchments of selected WBs), it creates unequal conditions for various actors of the same commercial sector.	**Low-Moderate** **DI**
LV8 Forest buffer zones			**Low-Moderate** **DI**
LV9 Proposals to reduce impact of agricultural activities	Impact on the State budget facing budgetary constraints ⇨ Society.		**Low**
LV10 Research and proposals for lakes with unknown reason "at risk"			**Low-Moderate**
LV11 (AD) Nutrients' retention ponds in AGR drainage systems	Due to economic burden created by the M.: - Reduced profitability of **farming** ⇨ Agricultural sector, **on selected areas.** - More expensive agricultural products ⇨ Consumers, "linked" industries. - Lost jobs due to reduced farming activity (close down of individual farms) ⇨ Local communities. - Abandoned agricultural lands (if farming becomes economically infeasible) ⇨ Regional communities, society.	The occurrence and magnitude of the wider impacts depend on intensity of the M. application. For LV11 and LV14 – with the given intensity (as proposed in the RBMPs), no considerable such impacts could be assumed. For the LV12 and LV13 – the direct impacts are rather low, thus also the wider impacts shouldn't be expected. When the M. is proposed on limited areas (catchments of selected WBs), it creates unequal conditions for various actors of the same commercial sector.	**Low-Moderate** **DI**
LV13 (AD) Sedimentation ponds to reduce impact of soil erosion from AGR lands			**Low?** **DI**
LV12 (AD) Sedimentation ponds to reduce impact of soil erosion from FOR activities and LV14 (AD) Sedimentation ponds as part of environment friendly management of FOR drainage systems	Due to economic burden created by the M.: - Reduced profitability of **forestry activity** ⇨ Forestry sector, **on selected areas.** - More expensive wood products ⇨ Consumers, "linked" industries. - Lost jobs due to reduced forestry activity ⇨ Local communities.		**Low?** **DI**
LV15 Improving ecological functionality of lakes	- Impact on the Municipal budgets facing budgetary constraints ⇨ Local communities. - Reduced profitability of economic activity ⇨ Private owners/renters of lakes, **on selected areas**.	Since the costs' burden is not estimated, magnitude of the wider impacts couldn't be assessed.	**NK**

Name of measure	Possible types of impacts and affected sectors/societal groups	Comments	Assessment
LV16 Investigation about measures for regulated rivers	Impact on the State budget facing budgetary constraints ⇨ Society.		**Low-Moderate**
LV17 Development of technical provisions for forest drainage systems			**Low**
LV18 Development of technical provisions for agricultural drainage systems			**Low**
LV19 Development of technical provisions for polders			**Low**
LV20 Environment friendly management of forest drainage systems	Due to costs' burden created by the M. on the forestry sector: Similar types of the impacts as for LV12, LV14.	When the M. is proposed on limited areas (catchments of selected WBs), it may create unequal conditions for various actors of the same commercial sector. Since the costs' burden is not estimated, magnitude of the wider impacts couldn't be assessed.	**NK (Low? DI?)**
LV21 Environment friendly management of agricultural drainage systems	- Due to costs' burden created by the M. on the agricultural sector: Similar types of the impacts as for LV11, LV13. - Budgetary impacts in case of public institutions as the implementation bodies. - Additional costs may arise due to boulders' placement if boulders are transported during flood events creating jams in unwanted areas.		**NK (Low-Moderate? DI?)**
LV22 Environment friendly management of polder systems	NK	Actual measures are not specified yet.	**NK**
LV23 Development of River Basin Management Information system	Impact on the State budget facing budgetary constraints ⇨ Society.	Since need for further funding is unclear (the M. is partly implemented), magnitude of the wider impact couldn't be assessed.	**NK**
LV24 Educational and Informational measures		Since need for funding is not estimated, magnitude of the wider impact couldn't be assessed.	**NK**
LV25 Organising public participation			**NK**
LV26 (AD) Improving ecological processes when maintaining regulations of rivers	- Similar socioeconomic impacts as for LV11, LV13, LV21. - Budgetary impacts in case of public institutions as the implementation bodies. - Costs may arise due to boulders' placement if boulders are transported during flood events creating jams in unwanted areas.	Implementation bodies are not specified and costs' burden not estimated, thus the impacts couldn't be assessed.	**NK**

Name of measure	Possible types of impacts and affected sectors/societal groups	Comments	Assessment
LV27 (AD) Improving ecological functionality of regulated rivers by naturalisation of river bed	NK - Budgetary impacts in case of public institutions as the implementation bodies. - Costs may arise due to boulders' placement if boulders are transported and deposited in unwanted areas during flood events.	Implementation bodies are not specified and costs' burden not estimated, thus the impacts couldn't be assessed.	**NK**
LV28 (AD) Management of Protected belts of water courses/ bodies	NK - Budgetary impacts in case of public institutions as the implementation bodies.		**NK**

The results don't indicate significant wider negative socioeconomic impacts from single measures – the assessment is bellow "moderate" impact for all the measures (where it could be developed). Although as noted the assessment is rather rough. For many measures the assessment was not possible, from the "technical" ones – in particular for those addressing the hydro-morphological pressures. However the cumulative impacts when few measures are applied to the same sector/sub-sector (in the same area) are not evaluated here. Such cumulative impacts could arise, for instance, for agricultural farms with crop and mixed production.

The results indicate considerable possible distributional impacts:

- impact on specific (size) group of a sector/sub-sector – from the measures LV1 and LV2;
- impact on sectors/sub-sectors on limited geographical areas, which can be expected from majority of the "technical" measures (from those where the assessment was possible) – LV3-8, LV11-14.

4.9.4 Relevant gaps for future work

Due to information gaps and limitations of this study only rough qualitative assessment of the indirect costs and wider negative socioeconomic impacts was possible. For considerable part of the measures, in particular the ones addressing the hydro-morphological pressures, the assessment could not be developed. **To apply the overall assessment approach as proposed by this study and to fill gaps and improve quality of the assessments, it is recommended**:

1. to improve information base and assessments on the direct socioeconomic impacts of the measures (the 'financial costs' and 'economic costs' in particular);
2. to carry out consultations with experts and stakeholders from the concerned sectors for improving information base on types of the "secondary"/wider impacts and their magnitude from various measures;
3. to elaborate further the assessment scale (categories), what would allow improving robustness of the assessments (e.g. what is "low" and what is "high" impact for each type of impacts);
4. to consider assessment of the cumulative impacts of measures as part of the impacts assessment of the overall programs of measures (on the RBD and national scale).

4.10 Certainty of effectiveness and costs' assessments (C7)

4.10.1 Relevance of the criterion

The relevance assessment based on the inquiry of specialists is provided in the next table. It shows that this criterion is commonly scored as important.

Table 4.18 Relevance assessment of the criterion based on results of the inquiry of specialists (2013).

Total number of responses – 12. The responses included assessment of each criterion by a scale from 1 "low relevance" to 5 "high relevance" and marking 5 the most important criteria from the listed (11 in total).

No of responses	12
SUM	45
Average	3.75
No of cases "among 5 the most important"	4
No of scores "4" and "5"	7
Mode (most frequently assigned score)	3 and 5
Median (middle of data row)	4
Range: Min/Max	1/5
No of scores "1" and "2"	1
Group	Important criterion

4.10.2 Definition of the criterion used in the study

This criterion is seen in connection to the assessment of cost-effectiveness of measure (C1). Thus, the certainty was assessed for the effectiveness' assessment in relation to the "targeted effect"[27] and for the assessment of 'financial costs'.

In general, certainty in the effectiveness and/or costs' assessments of a measure is considered low in cases when the assessments are very rough/uncertain and high in cases when there is good information and knowledge about what the actual costs and effects of measures are. More information about the used assessment categories is provided in the next chapter.

4.10.3 Assessment of measures using the criterion

The certainty of the effectiveness assessment[28] is related to information base used for the assessment, but also to character of the effectiveness of a measure and even to how clearly a measure has been specified. The certainty was assessed with 5-category scale from "1" meaning "very low" certainty to "5" meaning "very high certainty". The following aspects influencing the certainty of effectiveness' assessment were considered for specifying the assessment categories:

1. Definition of a measure – if a measures is clearly defined/specified that the effectiveness can be properly estimated.
2. If there are factors that introduce variations in the effectiveness.
3. Base data for estimating the effectiveness (e.g. certainty is higher if the estimates are based on national (monitoring) data/studies).

The assessment categories were specified as shown in the next table. The assessment was developed based on expert judgement (by the project's experts). The result is provided in the table 4.20.

[27] Certainty of the assessment on multiple effects of measures also should be assessed (was not done in this study). The evaluation of measures is conducted for each water quality pressure/problem separately. Since many measures have the multiple-effects they can be included in the evaluation for various problems.

[28] See the chapter 4.4.2 for information on this assessment.

Table 4.19 Specification of the assessment categories used for assessing certainty of the effectiveness' assessment.

Score	Specification	Interpretation
1	Very low	A measure is not clearly defined/specified that the effectiveness can be properly estimated.
2	Low	The effectiveness of a measure is highly dependent on set of activities for each case and the efficiency therefore is very case specific.
3	Moderate	There are factors that introduce considerable variations in the effectiveness (e.g. site specific characteristics, way of implementing a measure). Thus the actual effect can be lower/higher in some cases. The definition of a measure doesn't account fully these factors. No national data/studies are available on the effectiveness.
4	High	There are factors that can introduce certain variations in the effectiveness (for instance, effectiveness can change during operation if no specific actions are taken, e.g. cleaning of a sedimentation pond). No national data/studies are available on the effectiveness.
5	Very high	There are no factors introducing significant variations in the effectiveness. The estimate is based on national experience (data, studies).

Table 4.20 Assessment of certainty of the effectiveness' assessment of the measures. *(Source: Various information sources, the assessment developed by the project's experts.)*

Note: The effectiveness assessment is presented in the chapter 4.4.2. The certainty assessment categories are presented in the previous table. Measures without direct effect are not included in the table.

Name of measure (M)	Assessment (1-5)	Comments
LV1 Arranging environmentally safe manure storage facilities	3	Effect of the M. was calculated in the 1st RBMPs by ECOLAS model, which considers building of manure storage facilities. Content of the M. was changed latter by including also manure storage on field. But the quantitative estimate of effect was not changed. Thus, the effect might be overestimated and the efficiency might be lower.
LV2 Construction of biological WWTP in dairies	3	Calculation of nutrient load is based only on part of activities creating nutrient loads during operation of dairy, thus the actual load from the source might be higher and the estimated efficiency of the M., accordingly – lower.
LV3 Crop fertilisation planning	3	Nutrient load reduction estimate used in the ECOLAS model is based on set of activities (incl. also crop rotation plan), while RBMPs refers only to crop fertilisation planning. Therefore the used efficiency estimate might be lower in practice.
LV4 Winter green areas and stubble fields	3	The practical ways of application of the M. are quite unclear. Therefore efficiency might be lower in practice.
LV5 Green manure	3	Description of the M. is unclear with respect to size of area were the M. has to be applied. The nutrient load reduction efficiency is highly dependent also on agricultural machinery used for fertilizing of arable land (initial load with "conventional practice" to be reduced).
LV6 Agricultural land buffer zones (BZ) for LV6.1 water courses and bodies LV6.2 drainage systems	3 3	The nutrient loads reduction efficiency is highly dependent on (1) width of BZ; (2) type of soil; (3) agricultural machinery used for fertilizing of arable land (determining initial load with "conventional practice" to be reduced). With the assumed width the reduction efficiency is lower in the following cases: (1) for eutrophication sensitive water bodies and particularly for lakes; (2) if slope characteristics are > 8% [57]. Thu, the estimated efficiency of the M. might be lower in some cases.

Name of measure (M)	Assessment (1-5)	Comments
LV7 Good felling practice	1	Specification of the M. is not clear (e.g. what is prescribed by the M.) with respect to (1) size of area were the M. has to be applied and (2) % of trees left. Thus, the actual effectiveness of the M. cannot be estimated properly.
LV8 Forest buffer zones	3	The nutrient reduction efficiency depends on (1) % of trees left and (2) species of trees left. It is lost by 50% and additional hydro-morphological loads are created if river bank is overgrowth with old (approx. 30 years old) White Alder (*Alnus incana*).
LV11 (AD) Nutrients' retention ponds in AGR drainage systems	3	The nutrient reduction efficiency depends on (1) size of pond and (2) area of agriculture land served (need to be specified for the M. in the future).
LV12 (AD) Sedimentation ponds to reduce impact of soil erosion from FOR activities	3	The reduction efficiency depends on (1) the location of a pond and (2) timely implementation of the M. in connection to forestry activities. The reduction efficiency might be lower if measure is not implemented timely.
LV13 (AD) Sedimentation ponds to reduce impact of soil erosion from AGR land	4	The efficiency of a pond decreases during operation when it fills up with sediments, therefore site specific maintenance (cleaning) is needed to keep the efficiency. However the used efficiency estimate might decrease over time.
LV14 (AD) Sedimentation ponds as part of environment friendly management of FOR drainage systems	4	
LV15 Improving ecological functionality of lakes	2	The efficiency depends on what activities (specific set of activities) and with what purpose are required in each case, thus it is very case specific. In addition, efficiency of activities can depend also on their appropriate implementation (e.g. appropriate time for limiting overgrowth with macrophytes - the efficiency might be lower if optimal implementation time is not taken into account).
LV20 Environment friendly management of FOR drainage systems (LV20.2)	3 for [LV20.2]	The efficiency depends highly on whether beaver caused problems exist. The efficiency might be also higher for cases with problems targeted by the M.
LV21 Environment friendly management of AGR drainage systems (LV21.1 and 21.2)	3 for [LV21.1] 3 for [LV21.2]	For [LV21.1] The same as for [LV11]. For [LV21.2] The reduction efficiency is highly dependent on appropriate ditch management techniques and specific requirements used. Therefore achieved efficiency might be lower in practice.
LV22 Environment friendly management of polder systems	NA	(Actual measures are not specified yet.)
LV26 (AD) Improving ecological processes when maintaining regulations of rivers	3	The reduction efficiency is highly dependent on appropriate river management techniques and specific requirements used. Therefore achieved efficiency might be lower in practice.
LV27 (AD) Improving ecological functionality of regulated rivers by naturalisation of river bed	3	The M. foresees set of possible activities. The efficiency depends on degree of modifications of a river and proper identification and implementation of appropriate set of activities (for each case), thus it is highly site-specific. Efficiency achieved in practice might be lower.
LV28 (AD) Management of Protected Belts of water courses/bodies	4	The efficiency assessment is valid for cases with the described problems caused by lack of maintenance of Protected Belts. In particular, where river bank is overgrown with White Alder in age of 30-40 years.

The result shows that the certainty is moderate concerning majority of the measures (with only few cases with lower or higher certainty), thus the effectiveness' assessments should be improved in the future. Relevant gaps for future work are described in the chapter 4.4.2.3.

Like for the effectiveness, **the certainty in the costs' assessment**[29] was assessed with 5-category scale from "1" meaning "very low certainty" to "5" meaning "very high certainty". The following aspects influencing the certainty were considered for specifying the assessment categories:

1. Definition of a measure – if a measures is clearly defined/specified that the costs can be properly estimated.
2. If there are factors that introduce variations in the costs.
3. Base data for estimating the costs (e.g. certainty is higher if the estimates are based on national data and reflect the current prices).

The assessment categories were specified as shown in the table below.

Table 4.21 Specification of the assessment categories used for assessing certainty of the costs' assessment.

Score	Specification	Interpretation
1	Very low	A measure is not fully clear. For instance, it has been changed but the initial costs' estimate was not re-evaluated. Quantitative estimates of the costs used as basis for the costs' assessment are very uncertain.
2	Low	There are factors that introduce considerable variations in the costs (e.g. site specific characteristics, way of implementing a measure). Thus the actual costs can be lower/higher. Quantitative estimates of the costs used as basis for the costs' assessment are rather rough.
3	Moderate	There are no factors introducing significant variations in the costs.
+1 point		The estimate is based on national data.
+ 1 point		The costs reflect the current prices.

The assessment was developed based on expert judgement (by the project's experts). The result is provided in the table below.

Table 4.22 Assessment of certainty of the costs' assessment of the measures. *(Source: Various information sources, the assessment developed by the project's experts).*

Note: The costs' assessment is presented in the chapter 4.4.3. The certainty assessment categories are presented in the previous table. "-" a measure doesn't create the 'financial costs'. "NK" the certainty could not be assessed (mainly due to lack of the costs' assessment).

Name of measure (M)	Assessment (1-5)	Comments
LV1 Arranging environmentally safe manure storage facilities	2 (low)	Costs were calculated in the 1st RBMPs based on the ECOLAS model, which considers building of manure storage facilities. Content of the M. was changed latter (including also manure storage on field). But the quantitative estimate of costs was not changed. Thus, the costs are overestimated (in the case of storage on field). *[Category "2" from the scale]* The costs were estimated based on national data, but don't reflect the current prices (estimated in 2007).
LV2 Construction of biological WWTP in dairies	4 (high)	*[Category "3" from the scale]* The costs were estimated based on national data, but don't reflect the current prices (estimated in 2007).

[29] See the chapter 4.4.3 for information on this assessment.

Name of measure (M)	Assessment (1-5)	Comments
LV3 Crop fertilisation planning	2 (low)	The costs' estimate used in the ECOLAS model is based on set of activities (incl. also crop rotation plan), while the RBMPs refer only to crop fertilisation planning. Thus, it should be re-evaluated if the quantitative cost estimates need to be revised due to this. *[Category "1" from the scale]* The costs were estimated based on national data, but don't reflect the current prices (estimated in 2007).
LV4 Winter green areas and stubble fields	2 (low)	The same costs as for green manure were assumed. Besides content of a measure was changed latter including also stubble fields. But the quantitative estimates of costs were not changed. Thus, it should be re-evaluated if the quantitative cost estimates need to be revised due to this. Costs vary depending on the type of plant cover, the plant in question, area, and machinery of the farm. *[Category "1" from the scale]* The costs were estimated based on national data, but don't reflect the current prices (estimated in 2007).
LV5 Green manure	3 (moderate)	Costs can vary depending on type of plant cover, the plant in question etc. *[Category "2" from the scale]* The costs were estimated based on national data, but don't reflect the current prices (estimated in 2007).
LV6 Agricultural land buffer zones for LV6.1 water courses and bodies LV6.2 drainage systems	2 (low)	No 'financial costs' assumed for the RBMPs, although the M. might involve such costs (could not be assessed due to lack of information). *[Category "2" from the scale]* "2" scores for the certainty assessment considering the 'economic costs'. The costs primarily comprise the lost production on the agricultural production area, which should be evaluated using national (GIS) data (assumption based on Belgian data was used for the RBMPs). The costs are dependent highly on yield and prices. *[Category "1" from the scale]* The lost production was estimated based on national data, but don't reflect the current prices (estimated in 2007).
LV7 Good felling practice	2 (low)	No 'financial costs' assumed for the RBMPs, although the M. might involve such costs (could not be assessed due to lack of information). *[Category "2" from the scale]* "2" scores for the certainty assessment considering the 'economic costs'. Specification of the M. is not clear (e.g. what is prescribed by the M.) with respect to (1) size of area were the M. has to be applied and (2) % of trees left. Thus, the actual costs of the M. cannot be estimated properly. *[Category "1" from the scale]* The costs were estimated based on assumption and national data, but don't reflect the current prices (estimated in 2007).
LV8 Forest buffer zones	5 (very high)	The M. doesn't create the 'financial costs'. "2" scores for the certainty assessment considering the 'economic costs'. The costs primarily comprise the lost production on the area. It was estimated for the RBMPs using assumption (based on Belgian data) and national data (estimated in 2007). *[Category "1" from the scale]*
LV9 Proposals to reduce impact of AGR activities	5 (very high)	According to the approach used in the study, the direct (financial) costs of the M. are accounted as 'administrative costs'. Thus no 'financial costs'. "4" scores for the certainty assessment considering these 'administrative costs'. *[Category "3" from the scale]* They were estimated based on national data, but don't reflect the current prices (estimated in 2007).
LV10 Research and proposals for lakes with unknown reason "at risk"	5 (very high)	

Name of measure (M)	Assessment (1-5)	Comments
LV11 (AD) Nutrients' retention ponds in AGR drainage systems	1 (very low)	The costs' assessment builds on (the first) quantitative costs' estimates developed as part of this study. They are developed based on literature (e.g. average unit costs in Europe, for 2011). Moreover, different approaches are used to account various types of the costs in these estimates (transparent separation is not really possible). No national data are available for quantitative estimates on the costs. In addition, further specification is needed for the M. concerning technical characteristics (incl., size) of a pond. *[Category "1" from the scale]*
LV12 (AD) Sedimentation ponds to reduce impact of soil erosion from FOR activities	4 (high)	The costs' assessment builds on (the first) quantitative costs' estimates developed as part of this study. The quantitative estimates are developed based on average unit costs for building of such ponds and involve also assumptions. Further specification is needed for the M. concerning technical characteristics (incl., size) of a pond. *[Category "2" from the scale]* The costs' estimates are based on national data (for 2011-2012).
LV13 (AD) Sedimentation ponds to reduce impact of soil erosion from AGR land	4 (high)	
LV14 (AD) Sedimentation ponds as part of environment friendly management of FOR drainage systems	4 (high)	
LV15 Improving ecological functionality of lakes	NK	The 'financial costs' could not be assessed due to lack of information.
LV16 Investigation about measures for regulated rivers	5 (very high)	According to the approach used in this study, the direct (financial) costs of the M. are accounted as 'administrative costs'. Thus no 'financial costs'. "4" scores for the certainty assessment considering these 'administrative costs'. *[Category "3" from the scale]* They were estimated based on national data, but don't reflect the current prices (estimated in 2007).
LV17 Development of technical provisions for forest drainage systems	5 (very high)	
LV18 Development of technical provisions for agricultural drainage systems	5 (very high)	
LV19 Development of technical provisions for polders	5 (very high)	
LV20 Environment friendly management of FOR drainage systems (LV20.2)	NK	The 'financial costs' could not be assessed due to lack of information.
LV21 Environment friendly management of AGR drainage systems (LV21.1 and 21.2)	NK	
LV22 Environment friendly management of polder systems	NK	Actual measures are not specified yet.
LV23 Development of River Basin Management Information system	5 (very high)	According to the approach used in this study, the direct (financial) costs of the M. are accounted as 'administrative costs'. Thus no 'financial costs'. For the 'administrative costs' assessment, the costs were not estimated for the RBMPs, since implementation was assumed within budgets of responsible institutions. They couldn't be assessed also as part of this study due to limitations of the study.
LV24 Educational and Informational measures	5 (very high)	
LV25 Organising public participation	5 (very high)	

Name of measure (M)	Assessment (1-5)	Comments
LV26 (AD) Improving ecological processes when maintaining regulations of rivers	NK	The 'financial costs' could not be assessed due to lack of information.
LV27 (AD) Improving ecological functionality of regulated rivers by naturalisation of river bed	NK	
LV28 (AD) Management of Protected Belts of water courses/bodies	NK	

The result shows that the certainty could not be assessed for many measures, which is due to lack of the costs' assessment. Where it could be assessed, it is commonly low for the most measures with the 'financial costs'.

For combining the certainty assessments for both – the effectiveness and costs' assessment, the worst of the two assessments is used. The cost-effectiveness is estimated based on the effectiveness and costs' assessments. If the certainty of any of these assessments is low, also the total certainty assessment is low. The combined assessment is presented in the table below.

Table 4.23 Certainty of the effectiveness and costs' assessments of the measures. *(Source: Based on the separate certainty assessments for the effectiveness and costs.).*

Note: The assessment from 1 "very low" to 5 "very high". "-" a measure doesn't have direct effect. "NK" the certainty could not be assessed (mainly due to lack of the costs' assessment).

Name of measure (M)	Assessment (1-5)
LV1 Arranging environmentally safe manure storage facilities	2
LV2 Construction of biological WWTP in dairies	3
LV3 Crop fertilisation planning	2
LV4 Winter green areas and stubble fields	2
LV5 Green manure	3
LV6 Agricultural land buffer zones for	
LV6.1 water courses and bodies	2
LV6.2 drainage systems	2
LV7 Good felling practice	1
LV8 Forest buffer zones	3
LV9 Proposals to reduce impact of AGR activities	-
LV10 Research and proposals for lakes with unknown reason "at risk"	-
LV11 (AD) Nutrients' retention ponds in AGR drainage systems	1
LV12 (AD) Sedimentation ponds to reduce impact of soil erosion from FOR activities	3
LV13 (AD) Sedimentation ponds to reduce impact of soil erosion from AGR land	4
LV14 (AD) Sedimentation ponds as part of environment friendly management of FOR drainage systems	4
LV15 Improving ecological functionality of lakes	NK
LV16 Investigation about measures for regulated rivers	-
LV17 Development of technical provisions for forest drainage systems	-
LV18 Development of technical provisions for agricultural drainage systems	-
LV19 Development of technical provisions for polders	-

Name of measure (M)	Assessment (1-5)
LV20 Environment friendly management of FOR drainage systems (LV20.2)	NK
LV21 Environment friendly management of AGR drainage systems (LV21.1 and 21.2)	NK
LV22 Environment friendly management of polder systems	NK
LV23 Development of River Basin Management Information system	-
LV24 Educational and Informational measures	-
LV25 Organising public participation	-
LV26 (AD) Improving ecological processes when maintaining regulations of rivers	NK
LV27 (AD) Improving ecological functionality of regulated rivers by naturalisation of river bed	NK
LV28 (AD) Management of Protected Belts of water courses/bodies	NK

4.10.4 Relevant gaps for future work

No specific information gaps could be noted concerning the given criterion. Improving information base for assessing the effectiveness and costs[30] would allow application of this criterion.

4.11 Socioeconomic benefits from environmental improvements (C8)

4.11.1 Relevance of the criterion

Relevance assessment of the criterion based on the inquiry of specialists is provided in the table below. It shows that this criterion is commonly highly scored and is ranked among 5 the most important criteria for evaluation and selection of 'supplementary' measures (together with the multiple effects of measures, acceptance by stakeholders, cost-effectiveness of measures and certainty in funding availability).

Table 4.24 Relevance assessment of the criterion based on results of the inquiry of specialists (2013).

Total number of responses – 12. The responses included assessment of each criterion by a scale from 1 "low relevance" to 5 "high relevance" and marking 5 the most important criteria from the listed (11 in total).

No of responses	12
SUM	52
Average	4.3
No of cases "among 5 the most important"	8
No of scores "4" and "5"	10
Mode (most frequently assigned score)	5
Median (middle of data row)	4.5
Range: Min/Max	3/5
No of scores "1" and "2"	0
Group	Criterion of highest priority

[30] See the chapters 4.4.2.3 and 4.4.3.3 on gaps concerning the effectiveness and costs' assessments.

4.11.2 Definition of the criterion used in the study

The socioeconomic benefits from environmental improvements (from water-related and environment-related side effects) are treated in the study as benefits to society and economy from improved water and environmental quality achieved by implementing a measure.

The "water-related" benefits arise from improvements in the concerned WBs. The socioeconomic benefits from environmental improvements should take into account both the "use value" and the "non-use" value of affected water ecosystems.

The benefits from "environment-related side effects" occur if a measure gives also improvements besides those directly related to the water environment, e.g. has a positive impact also on terrestrial biodiversity, soil quality, air emissions etc.

4.11.3 Assessment of measures using the criterion

The assessment builds on collecting and reviewing available information. The used information base is discussed below for each type of environmental improvement (for the water-related and environment-related side effects).

Benefits from water-related environmental improvements

Socioeconomic benefits from water quality improvements in Latvia primarily relate to water use for recreation and industrial fishing. These uses benefit also from "regulating ecosystem services" provided by the water ecosystems, including those provided by the coastal marine ecosystem, for instance, regulation of eutrophication, hazardous substances, biological regulation, sediment retention. The "non-use" value of the ecosystems also needs to be accounted.

Assessment of the benefits of improving state of WBs requires understanding links between various water quality improvements – in terms of their types (water quality elements) and level (classes e.g. "good", "moderate", "poor") and human wellbeing outcomes. In practical terms, water status is characterised by water quality elements and physical indicators, and the assessment of the benefits requires linking changes in these elements and indicators, which result from implementing measures, to changes in the humans' welfare (e.g. from increased recreational, amenity value, "non-use" value of water ecosystems etc.).

A study that addresses the issue above was conducted as part of this project.[31] The analysis focused on water uses that depend on good quality of surface inland waters (rivers and lakes). The main such uses in Latvia are swimming & near-water recreation, boating & water sports, angling and industrial fishing.

The linkages between these water uses and the WFD water quality elements and the dependence of each use on the "good" water status was assessed. The assessments were developed based on information about national regulatory requirement, evidences from literature and experts' knowledge. The overall linkages are illustrated in the next table. It should be stressed that the linkages differ for various types of waters (e.g. ritron and potamon rivers, lakes). For instance, the hydrological regime and morphological conditions are important only for angling in ritron rivers (on salmonid fish) and industrial fishing in rivers, but they are not relevant for the given uses in potamon rivers (e.g. angling on cyprinid fish) and lakes.[32]

[31] Pakalniete K. (2013) Assessing socioeconomic significance of water use for the WFD river basin management planning. Latvian study report. Gauja/Koiva project.

[32] See the referred report for more detailed information on these results.

Table 4.25 Overall linkages between the WFD water quality elements and water uses dependant on good quality (for inland surface waters). *(Source: Pakalniete K. (2013) "Assessing socioeconomic significance of water use for the WFD river basin management planning. Latvian study report." Gauja/Koiva project.)*

* Linked water quality elements differ for various types of waters (ritron and potamon rivers, lakes). All water types are considered together here. The linkages for each type of waters are analysed and specified separately in the study.

Group of water quality elements	Water quality elements	Water uses dependant on good water quality			
		Angling*	Swimming & near-water recreation	Boating & water sports	Industrial fishing*
Biological elements	Fish	x			x
	Other biological elements (phytoplankton, macrophytes, benthic invertebrate fauna)	x	x	x (macrophytes)	x
Hydro-morphological elements (supporting the biological elements)	Hydrological regime	x			x
	Morphological conditions	x			x
	Continuity	x			x
Chemical and physicochemical elements (supporting the biological elements)	Transparency	x	x		
	Thermal conditions	x			x
	Oxygen and nutrients	x	x		x

For each link also dependence of the uses on various water quality levels (classes) was assessed – the water quality level (class) at which each activity becomes bothered and at which impossible. [33] It was concluded overall that all the analysed water uses are dependent on good water quality, but they need "good" water status (class) on different extents.[34]

Such assessment allows understanding occurrence of various types of ("use") benefits depending on certain water quality improvements – in terms of the improvements' type (water quality elements) and level (quality class). In practice, when the current status of a WB is assessed in terms of water quality elements and classes for them, the water quality improvements above the current status would indicate for which water uses the benefits potentially could occur. The different dependence of the uses on the water quality improvements should be taken into account when valuing actual benefits to avoid their overestimation.

For the evaluation of measures the benefits resulting from implementation of specific measures need to be evaluated. The capacity of each measure to improve water quality in relation to various

[33] For instance, if an activity becomes bothered only when status start failing "poor" quality class for relevant water quality element, there would be no (marginal) benefits for this activity from improving state above the "poor" for this element (e.g. to "moderate" and further to "good"). Thus, the measures for improving state above the "poor" status would not create benefits for this activity.

[34] For instance, angling in ritron rivers (on salmonid fish) might become impossible just as the quality fails GES, thus the benefits potentially could occur for this activity from improving the state in all WBs (of this type of waters) failing GES. At the same time, angling in potamon rivers (on cyprinid fish), industrial fishing in rivers and all the uses in lakes might become bothered only at the "poor" status and impossible only when the water status is "bad". Thus, they would not derive welfare gains from improving the state above the "poor" quality class. See the study report for detailed results.

water quality elements is indicated by the assessment of environmental (water-related) effects of the measures as part of this study (the results are presented in the chapters 4.4.2 and 4.6, and the Annex 4). These results were viewed together with the results on the linkages between water quality elements and uses dependant on good water quality (results from the study above). It was assessed for each measure whether it provides improvements for water quality elements relevant for the uses dependant on good water quality. In addition, also literature was reviewed to collect information on types of benefits from implementing various measures.

However, it should be stressed that in reality:

- the "use" benefits may be limited due to natural characteristics of WBs determining their suitability for various water uses, presence of "substitute" water bodies nearby providing similar benefits, maximum number of beneficiaries in concerned area (for instance, how many new "users" could be accounted due to opening new recreational opportunities from improving state of a WB);
- the benefits will depend on the current status of WBs (e.g. the current "damage" in terms of "use" and "non-use" value that would be averted by implementing a measure) and quantity of such WBs failing good quality in the area concerned by implementation of measures.

This type of analysis would require a special study. Since the actual benefits will be determined by location and scope of the measures' application (concerned WBs), the assessment of benefits developed in this study indicates rather hypothetical than actual benefits from implementing the measures.

As an additional information source, the economic valuation studies conducted in Latvia so far were reviewed. Four studies have valued various types of benefits from water quality improvements.[35] Due to specific focus and/or area of each study they don't provide sufficient information base to assess the wide range and magnitude of the benefits, incl. in relation to all relevant water quality problems (for instance, benefits from improving hydro-morphological quality of inland surface waters have not been valued at all). However, they provide evidences on the benefits (based on "willingness to pay" of the Latvian inhabitants) from improving the inland and coastal water quality.

Benefits from the environment-related side effects

No studies have been conducted in Latvia so far that would provide assessments of benefits of the WFD measures in relation to their environment-related side effects. Thus a literature review was conducted to collect information about potential types of such effects/benefits for various measures. It should be noted however, that actual effects and benefits can differ depending on specification and application of measures.

[35] References for these studies:

1) [A study on benefits from improving shallow groundwater quality under the city of Riga in relation to pollution with oil products] Pakalniete K., Bouscasse H., Strosser P. (2006) *Assessing socio-economic impacts of different groundwater protection regimes. Latvian case study report.* Report of the FP6 Research project „Background Criteria for the Identification of Groundwater Thresholds" (BRIDGE).

2) [A study on benefits from improving river and lake water quality in relation to eutrophication for selected WBs] Pakalniete K., Lezdina A., Veidemane K. (2007) *Assessing environmental costs by applying Contingent Valuation method in the sub-basin of the river Ludza.* Latvian case study. Report of the project ENCO-BALT.

3) [A study on benefits from improving marine water quality in relation to eutrophication] Ahtiainen H. et.al (2012) *Benefits of meeting the Baltic Sea nutrient reduction targets - Combining ecological modelling and contingent valuation in the nine littoral states*. MTT Discussion Papers 1/2012.

4) [A study on benefits from improving marine (incl. coastal) water quality in relation to various environmental problems, e.g. eutrophication, decline of biodiversity, introduction of alien species] Pakalniete K. et.al (2013) *Valuing benefits of reaching the MSFD targets by applying the 'Choice Experiment' Method. Latvian study report*. Report of the Central Baltic INTERREG IVA program project "GES-REG".

Therefore the main basis for considering such benefits was the assessment of such environmental effects of the measures developed as part of this study (provided in the Annex 5). It shows whether positive effects can occur from implementing a measure in relation to specific elements of the environment (e.g. terrestrial ecosystems, groundwater, air quality etc.).[36] It should be stressed that this assessment doesn't reflect magnitude of these effects. Information base is not sufficient for assessing it, also because the magnitude can depend on scope of the measures' application.

The result shows that almost all the considered elements of the environment are affected positively by nutrients' retention ponds and environment friendly management of agricultural drainage systems, which considers also establishing the retention ponds (LV11 and LV21), and management of the Protected Belts (LV28). More than half of the elements is affected by the agricultural buffer zones (LV6), improving ecological functionality of regulated rivers by naturalisation of river bed (LV27), arrangement of environmentally safe manure storage facilities (assuming isolated facilities) and winter green areas (LV1 and LV4). These could be seen as measures creating the highest potential benefits from environment-related side effects.

Assessment of the socioeconomic benefits from environmental improvements

The information discussed above in this chapter formed basis for developing the assessment based on expert judgement. The assessment was developed by the project's experts using 5-category scale from 1 "low possible benefits" to 5 "high possible benefits". It builds in particular on:

- the assessment of water quality elements affected by each measure (included in the Annex 4);
- assessment of water quality elements affected by each measure that are relevant for the uses dependant on good water quality of rivers and lakes (based on the "linkage analysis" as discussed earlier in this chapter);
- the assessment of elements of the environment affected positively as side effects of each measure (included in the Annex 5).

The table below includes the assessment of possible socioeconomic benefits from environmental improvements associated with implementation of each measure.

It has to be stressed that:

- the benefits are rather hypothetical, since the actual benefits from implementing the measures will be determined by location and scope of the measures' application (concerned WBs), which has not been analysed;
- the assessment reflects rather relative magnitude of the befits of the measures against each other than absolute magnitude, since available information base doesn't allow assessing the latter.

[36] 7 such elements of the environment are considered: (1) terrestrial ecosystems, (2) groundwater, (3) soil quality, (4) air quality, (5) landscape quality, (6) flood control, (7) biodiversity in new water biotope. The positive effect of each measure on each element is assessed (with "Yes"/"No") based on expert judgement.

Table 4.26 Assessment of the possible socioeconomic benefits from environmental improvements associated with implementation of the measures. *(Source: Various information sources, the assessment developed by the project's experts.)*

The assessment with 5-category scale from 1 "low possible benefits" to 5 "high possible benefits".

Name of measure	Assessment (1-5)
LV1 Arranging environmentally safe manure storage facilities	**3**
LV2 Construction of biological WWTP in dairies	**2**
LV3 Crop fertilisation planning	**2**
LV4 Winter green areas and stubble fields	**3**
LV5 Green manure	**2**
LV6 Buffer zones in agricultural land	**4**
LV7 Good felling practice	**3**
LV8 Forest buffer zones	**3**
LV9 Proposals to reduce impact of agricultural activities	-
LV10 Research and proposals for lakes with unknown reason "at risk"	-
LV11 (AD) Nutrients' retention ponds in AGR drainage systems	**4**
LV12 (AD) Sedimentation ponds to reduce impact of soil erosion from FOR activities	**3**
LV13 (AD) Sedimentation ponds to reduce impact of soil erosion from AGR lands	**3**
LV14 (AD) Sedimentation ponds as part of environment friendly management of FOR drainage systems	**3**
LV15 Improving ecological functionality of lakes	**4**
LV16 Investigation about measures for regulated rivers	-
LV17 Development of technical provisions for forest drainage systems	-
LV18 Development of technical provisions for agricultural drainage systems	-
LV19 Development of technical provisions for polders	-
LV20 Environment friendly management of forest drainage systems (LV20.2)	**3**
LV21 Environment friendly management of agricultural drainage systems (LV21.1 and LV21.2)	**5**
LV22 Environment friendly management of polder systems	**NK**
LV23 Development of River Basin Management Information system	-
LV24 Educational and Informational measures	-
LV25 Organising public participation	-
LV26 (AD) Improving ecological processes when maintaining regulations of rivers	**4**
LV27 (AD) Improving ecological functionality of regulated rivers by naturalisation of river bed	**4**
LV28 (AD) Management of the Protected Belts of water courses/ bodies	**5**

As can be seen from the assessment, the relatively highest possible benefits could be expected from the agricultural measures in relation to buffer zones, nutrient' retention ponds and environment friendly management of drainage systems (incl., also the retention ponds) (LV6, LV11, LV21), the improving ecological functionality of lakes (LV15), the measures improving ecology of straightened rivers (LV26, LV27) and the management of Protected Belts (LV28).

4.11.4 Relevant gaps for future work

The developed assessment is rough and reflects rather relative magnitude of the benefits of the measures against each other than absolute magnitude of the benefits, since available information base doesn't allow assessing the latter.

The benefits of measures depend on types of the water quality improvements (e.g. which water quality elements a measure impacts) and on how changes in the water quality are linked to water uses and humans' welfare. Moreover, when linking changes in state of WBs achieved by measures' implementation to the humans' welfare, the magnitude of the benefits will depend on natural characteristics of WBs determining their suitability for various water uses, presence of "substitute" water bodies nearby providing similar benefits, number of beneficiaries in concerned area and other location specific conditions. **The WB-scale analysis is required to support assessing size of the benefits, when application of the measures would be analysed for concrete areas (WBs).**

Additional work is needed for quantification (incl., monetary estimation if necessary) of the benefits since the economic valuation studies conducted in Latvia so far don't provide sufficient information base (in particular, concerning the inland waters).

4.12 Availability of enforcement schemes for implementing measures (C9)

4.12.1 Relevance of the criterion

The relevance assessment based on the inquiry of specialists is provided in the table below.

Table 4.27 Relevance assessment of the criterion based on results of the inquiry of specialists (2013).

Total number of responses – 12. The responses included assessment of each criterion by a scale from 1 "low relevance" to 5 "high relevance" and marking 5 the most important criteria from the listed (11 in total).

No of responses	12
SUM	42
Average	3.5
No of cases "among 5 the most important"	3
No of scores "4" and "5"	7
Mode (most frequently assigned score)	4
Median (middle of data row)	4
Range: Min/Max	1/5
No of scores "1" and "2"	2
Group	Important criterion

4.12.2 Definition of the criterion used in the study

Overall the enforcement practices refer to institutions in place that provide **incentives** for **compliance** with the policies in place. Enforcement requires that rights and obligations are legally defined, monitoring and inspections schemes are in place and that there are economic and social incentives for compliance.

In order to assess each measure, the following elements in relation to enforcement (concerning each measure) were considered:

1. if the **legal basis** and **responsibilities** for implementing a measures are clearly defined;

2. if the legal and institutional **schemes**, incl. institutions, **for supervising and control** of implementation of a measure are in place;
3. if the **instruments** providing **incentives** for compliance (e.g. financial support schemes, penalties) are in place.

These elements were analysed for each measure and taken as basis for developing the assessment for the criterion.

4.12.3 Assessment of measures using the criterion

The assessment for each measure was developed based on expert judgement (by the project's experts) using 5-category scale from "1" meaning that the enforcement schemes are "not existing" to "5" meaning they are "fully operational". For instance, the assessment is "5" if "Yes" answer can be provided on all the three questions above.

It should be noted that the assessment doesn't take into account **efficiency** of enforcement schemes, instruments etc., since special research would be required for assessing this. Only presence in principle is evaluated.

The assessment is provided in the table below. It shows for each measure the answers on previously listed questions (1-3) and the summary assessment with the given scale (from 1 "not existing" to 5 "fully operational").

Table 4.28 Assessment of the availability of enforcement schemes for implementing the measures. *(Source: Various information sources, the assessments developed by the project's experts.)*

Notes:

For the questions 1-3 (Q1-Q3): "+" Yes; "+/-" partly Yes, partly No; "-" No; "?" Not know/uncertainty.[37]

For the assessment (A): from 1 "not existing" to 5 "fully operational".

Measures for which the enforcement schemes need to be established/improved in the future (for the 2nd implementation cycle) to make them operational.

Name of measure	Assessment				Name of measure	Assessment			
	Q1	Q2	Q3	A		Q1	Q2	Q3	A
LV1 Arranging environmentally safe manure storage facilities	+	+	-	**4**	LV15 Improving ecological functionality of lakes	+	+/-	+/-	**4**
LV2 Construction of biological WWTP in dairies	+	+/-	- ?	**3**	LV16 Investigation about measures for regulated rivers	+	+ ?	-	**4**
LV3 Crop fertilisation planning	+	+/-	+/-	**4**	LV17 Development of technical provisions for FOR drainage systems	+	+	-	**4**
LV4 Winter green areas and stubble fields	+	+ ?	+/- ?	**4**	LV18 Development of technical provisions for AGR drainage systems	+	+	-	**4**
LV5 Green manure	+	+ ?	+/- ?	**4**	LV19 Development of technical provisions for polders	+	+	-	**4**

[37] It should be noted concerning the question 1 in relation to the legal status of measures that all 'supplementary' measures are voluntary by their legal status in Latvia (not set by the national laws/regulations). Thus legal status of all analysed measures is less "strong" than for the 'basic' measures. However, this was seen as an issue of efficiency of the status (voluntary/mandatory), which is not evaluated in this assessment. Thus, "Yes" (+) is assigned for the measures if they are specified clearly in the 1st RBMPs and the implementation bodies are also clearly specified.

Name of measure	Assessment				Name of measure	Assessment			
	Q1	Q2	Q3	A		Q1	Q2	Q3	A
Agricultural land buffer zones for LV6.1 water courses and bodies	+	+?	-	**3-4**	LV20 Environment friendly management of FOR drainage systems (LV20.2)	+/-	-	-	**2**
LV6.2 drainage systems	-	-	-	**1**					
LV7 Good felling practice	+/-	+/-	-	**3**	LV21 Environment friendly management of AGR drainage systems (LV21.1 and 21.2)	+/-	-	-	**2**
LV8 Forest buffer zones	+	+/-	-	**3**	LV22 Environment friendly management of polder systems	+/-	-	+/-	**3**
LV9 Proposals to reduce impact of agricultural activities	+	+	-	**4**	LV23 Development of RB Management Information system	+	+	-	**4**
LV10 Research and proposals for lakes with unknown reason "at risk"	+	+	-	**4**	LV24 Educational and Informational measures	+	+/-	+/-	**4**
LV11 (AD) Nutrients' retention ponds in AGR drainage systems	-	-	-	**1**	LV25 Organising public participation	+	+/-	+/-	**4**
LV12 (AD) Sedimentation ponds to reduce impact of soil erosion from FOR activities	-	-	-	**1**	LV26 (AD) Improving ecological processes when maintaining regulations of rivers	-	-	-	**1**
LV13 (AD) Sedimentation ponds to reduce impact of soil erosion from AGR land	-	-	-	**1**	LV27 (AD) Improving ecological functionality of regulated rivers by naturalisation of river bed	-	-	-	**1**
LV14 (AD) Sedimentation ponds as part of environment friendly management of FOR drainage systems	+/-	-	+/-	**3**	LV28 (AD) Management of Protected belts of water courses/bodies	-	-	-	**1**

4.12.4 Relevant gaps for future work

The results indicate that many measures require considerable further work for **establishing the enforcement schemes, instruments etc**. It can be said in particular concerning the new measures elaborated as part of the study – in relation to sedimentation and retention ponds (LV11-13) and measures for straightened rivers (LV26-27). But it concerns also part of measures included in the 1st RBMPs, like LV7 “Good felling practice”, LV8 “Forest buffer zones” and measures for environment friendly management of drainage systems and polders (LV20-22).

Common problem for all the measures is **insufficient/lack of instruments providing incentives** for their implementation. Since all the ‘supplementary’ measures are voluntary by their legal status, clear and strong incentives for their implementation (in particular, the economic ones) will play an important role to ensure their implementation.

In addition, the **knowledge base on efficiency of enforcement practices** should be improved overall in the future. For instance, there is not enough information about enforcement instruments that they would provide enough incentives for farmers and forest owners to take the measures (e.g. buffer zones, sedimentation and retention ponds, environment friendly management of drainage systems). Improved knowledge base on this issue would help for designating effective policy (measures) and planning efforts for improving the enforcement.

4.13 Acceptance by stakeholders (C10)

4.13.1 Relevance of the criterion

Relevance assessment of the criterion based on the inquiry of specialists is provided in the table below. It shows that this criterion is commonly highly scored and is ranked among 5 the most important criteria for evaluation and selection of measures (together with the socioeconomic and environmental benefits, cost-effectiveness of measures and availability of funding for implementing measures).

Table 4.29 Relevance assessment of the criterion based on results of the inquiry of specialists (2013).

Total number of responses – 12. The responses included assessment of each criterion by a scale from 1 "low relevance" to 5 "high relevance" and marking 5 the most important criteria from the listed (11 in total).

No of responses	12
SUM	50
Average	4.17
No of cases "among 5 the most important"	8
No of scores "4" and "5"	9
Mode (most frequently assigned score)	5
Median (middle of data row)	4
Range: Min/Max	3/5
No of scores "1" and "2"	0
Group	Criterion of highest priority

4.13.2 Definition of the criterion used in the study

Experience from the 1st implementation cycle shows that the acceptance of stakeholders is an important precondition for implementation of the measures. The acceptance may depend on various reasons, for instance, knowledge about costs and other impacts of a measure, distrust to (positive) environmental effect, insufficient financial incentives (support) for implementing a measure etc. Since various stakeholders have different interests and perspectives for their acceptance of various measures, the acceptance for each measure is defined here taking into account the stakeholders concerned by its implementation.

4.13.3 Assessment of measures using the criterion

A review of available national information in relation to the stakeholders' acceptance of the WFD 'supplementary' measures was conducted. The following information sources were used in particular as basis for developing the assessment:

- Public inquiry on support to measures and their implementation for the 'supplementary' measures proposed in the (draft) RBMPs, which was conducted in 2009 as part of public consultations in each RBD.
- Inquiry of members of the River Basin Consultative Boards on importance of the 'supplementary' measures included in the 1st RBMPs, which was conducted in 2010 for each RBD.
- Previous implementation practice, including participation activity in implementation of the measures (e.g. in the CAP voluntary agro-environmental funding schemes, educational,

informational and public participation measures) that provides indirect indication on the acceptance of measures;

- Own expert knowledge.

Both inquiries are briefly described below.

Public inquiry on support to 'supplementary' measures proposed in the (draft) RBMPs (2009)

The inquiry aimed to gather opinions of stakeholders concerning the proposed measures. It was conducted for each RBD. The responses were collected by a questionnaire where one of the questions was about personal willingness to implement the proposed 'supplementary' measures. All the main stakeholders' groups were covered, and each group was inquired about the measures concerning them. The responses were collected as part of the public consultation meetings, via e-mail (addressed personally) and internet. 112 responses were collected in total from all RBDs, from which 17 responses were received from representatives of the agriculture and 7 of the forestry sectors.

It should be noted that the inquiry was conducted based on the draft RBMPs with preliminary list and description of the measures. It differs slightly from the list and description of measures included in the final RBMPs (which was used as basis for this study).

It should also be noted that for the most measures addressing pressures from agriculture and forestry the number of responses overall is rather small to develop representative assessments on the stakeholders' acceptance. Thus the results could be used only for indicating possible general tendencies or problems:

- There are measures with large proportion of responses that the measure is unclear (according to the list in this study, these are the measures LV7, LV8, LV16 and the follow-up "technical" measures, LV17-LV19 and the follow-up "technical measures" LV20-LV22). This indicates that more detailed and clear information on these measures (what is asked practically from those who would implement the measures) is needed. It also indicates that the stakeholders' acceptance can't be measured effectively before this is specified.
- There were almost no responses of definite objection against a measure, and no such responses at all for measures concerning agriculture and forestry. Even if a measure was not fully clear its implementation was not refused.
- The highest support was shown for the following measures (according the list of this study) – LV1, LV3, LV5, LV20, LV22, LV24, the lowest support for LV4, LV6.1, LV8. However, as noted the results should be viewed with caution due to the small number of responses overall.
- There is relatively low acceptance for some measures that are proposed in the RBMPs based of the CEA. It concerns such measures as winter green areas and stubble fields (LV4) and riparian buffer zones for agriculture (LV6.1), although might be also for forest riparian buffer zones and Good Felling Practice (the number of responses here was too small for any conclusions). They have been proposed in the RBMPS as being cost-effective according to calculations by the CEA (ECOLAS) model. The inquiry indicates that the acceptance depends on other socioeconomic issues also. To our knowledge there has been no investigation in Latvia on these issues. Besides, there are other indications also that the current acceptance of such measure as riparian buffer zones for agriculture might not be sufficient to ensure full implementation of this measure according to the RBMPs.[38]

[38] This measure was among the supported measures in the previous CAP period (as the agro-environmental funding scheme). The participation activity of farmers in this scheme was valued as relatively low overall.

Inquiry of members of RB Consultative Boards on importance of the 'supplementary' measures (2010)

The aim of the inquiry was to elicit assessment of importance of measures in light of their implementation. It doesn't measure the acceptance directly, however gives indirect indication for it.

The inquiry was conducted among members of the River Basin Consultative Boards for each RBD. 40 persons were inquired overall. Those measures that are included in the 1st RBMPs of each RBD were assessed by each Board (this explains small number of responses in some cases, since some measures are proposed in one/two RBD only). Each measure was assessed with a scale from 1 to 10, where "10" means that a measure is seen as the most important.

The results show that the highest importance was assigned to such measures as LV3, LV4-6 (were assessed together in a set), LV10, LV15, LV17-19 (also assessed together in a set) and LV23-LV25. The lowest importance was assigned to LV7-8 and LV20-22 (both assessed in sets). However the results should be viewed with caution due to small number of responses in some cases as well as methodological characteristics of the study.

When comparing these results to those from the stakeholders' inquiry, importance of some measures is seen rather differently (e.g. LV4, LV6.1, LV20, LV22).

The assessment for this study was developed based on expert judgement (by the project's experts). The stakeholders' acceptance was assessed for each measure using 5-category scale from "1" meaning "low" to "5" meaning "high" acceptance (or "not sufficiently known" where the knowledge about the acceptance is not sufficient). The assessment is provided in the following table.

Table 4.30 Assessment of the measures' acceptance by stakeholders concerned by implementing the measures. *(Source: Various information sources, the assessment developed by the project's experts.)*

Notes: Assessment using scale from 1 "low" to 5 "high" acceptance, or "not sufficiently known" (NK) due to lack of information.

* Without/with (full) public financial support.

Measures for which the acceptance needs to be investigated and/or where it is critical to improve the acceptance to make the measures operational.

Measures for which investigating and/or improving acceptance would be recommended.

Name of measure	A	Name of measure	A
LV1 Arranging environmentally safe manure storage facilities	**3**	LV15 Improving ecological functionality of lakes	**4**
LV2 Construction of biological WWTP in dairies	**3/NK**	LV16 Investigation about measures for regulated rivers	**4**
LV3 Crop fertilisation planning	**4?**	LV17 Development of technical provisions for FOR drainage systems	**4**
LV4 Winter green areas and stubble fields	**4?**	LV18 Development of technical provisions for AGR drainage systems	**4**
LV5 Green manure	**4?**	LV19 Development of technical provisions for polders	**4**
LV6 Agricultural land buffer zones for LV6.1 water courses and bodies LV6.2 drainage systems	**2/4 *** **NK**	LV20 Environment friendly management of FOR drainage systems (LV20.2)	**NK**
LV7 Good felling practice	**3**	LV21 Environment friendly management of AGR drainage systems (LV21.1 and 21.2)	**NK**

Name of measure	A	Name of measure	A
LV8 Forest buffer zones	**2**	LV22 Environment friendly management of polder systems	**3/NK**
LV9 Proposal to reduce impact of agricultural activities	**NK**	LV23 Development of RB Management Information system	**4**
LV10 Research and proposals for lakes with unknown reason "at risk"	**4**	LV24 Educational and Informational measures	**4**
LV11 (AD) Nutrients' retention ponds in AGR drainage systems	**NK**	LV25 Organising public participation	**4**
LV12 (AD) Sedimentation ponds to reduce impact of soil erosion from FOR activities	**NK**	LV26 (AD) Improving ecological processes when maintaining regulations of rivers	**NK**
LV13 (AD) Sedimentation ponds to reduce impact of soil erosion from AGR land	**NK**	LV27 (AD) Improving ecological functionality of regulated rivers by naturalization of river bed	**NK**
LV14 (AD) Sedimentation ponds as part of environment friendly management of FOR drainage systems	**3/NK**	LV28 (AD) Management of Protected belts of water courses/bodies	**NK**

4.13.4 Relevant gaps for future work

Taking into account the importance of the criterion, the **information availability for assessing the acceptance of measures** is not sufficient overall for developing reliable assessments. Moreover, to our knowledge, there have been no investigations in Latvia on factors determining acceptance of various measures. Such knowledge would be useful for policy makers and responsible institutions for planning efforts to improve the acceptance of measures that are proposed in the RBMPs.

As indicated in the previous table the following measures should be investigated in particular:

1. Buffer zones for agriculture and forestry, Good Felling Practice (LV6-LV8);
2. Environmentally friendly management of drainage systems and polders (LV20-22);
3. Retention and sedimentation ponds for drainage systems and measures for improving ecology and hydro-morphology of regulated rivers (LV11-LV14, LV26-LV28).

The measures under the first point above were agreed in the 1st RBMPs. However their acceptance might be insufficient, thus better understanding of reasons for it and work for improving the acceptance is relevant for future implementation of these measures. Similar conclusion and recommendation can be made concerning the measures under the second point – also these measures are considered in the 1st RBMPs already (although actual content of the measures was not specified) but the acceptance level is not really clear.

The measures under the point 3 have not been specified or even proposed in the 1st RBMPs. Although there are application cases for some of them in Latvia, they might be not sufficiently known by stakeholders.

To get better insight into stakeholders' acceptance of various measures including the main concerns of farmers and potentially relevant issues for building the acceptance, an experience from other countries was briefly reviewed. It was done based on a recent study on exchanging experience from RBM in the EU countries. The following table summarises the main results of this study concerning the stakeholders' acceptance of measures for reducing nutrients pollution from agriculture.[39] Only the measures that are similar or related to those analysed in this study are included in the table.

[39] Countries that provided responses for this study are DK, EE, ES, FL, FR, IT, LUX, NL, NO, PL, RO, SE, SL, UK.

Table 4.31 Stakeholders' acceptance of (additional) measures in the RBMPs for reducing nutrients' pollution from agriculture – experiences from the EU countries. *(Source: Somma F. (ed.) (2013).)*

Note: the summary is built based on responses from various countries, in particular, DK, EE, FR, NO, PL, RO, SE, SL, UK.

(*) Adapting the amount of used mineral fertilizers and manure to the current legislation and lowering application below an economical optimum.

Name of measure	General trends on acceptance of measure	The main concerns of farmers	Relevant issues for the acceptance
Provide manure storage capacity	Relatively well accepted by farmers since recognised as important.	Not enough support schemes to meet the requirements.	Public financial support. Awareness of potential economic gains (e.g. gains from improved application of manure from more appropriate storage).
Avoid spreading fertiliser and manure at high risk times and places	Relatively good / various among farmers. Well accepted by local population if known.	Hesitation on the environmental impact of the measures. May cause inconveniences such as high costs (e.g. due to implications for manure storage) or soil compaction.	Availability of advisory services. Previous experience with implementing the measure. Awareness of potential economic gains (e.g. improved fertiliser potential in soil, save of fertilisers and money as a result)
Application techniques of manure (manure handling)	Seen as important or farmers' acceptance not known. Well accepted by local population (reduced odour).		Awareness of potential economic gains from better nutrient use. Early involvement of farmers. Availability of advisory services.
Plant cover in winter	Good overall among farmers.	Types of winter crops and that the crop rotation can be aligned with farmers rotation.	Early involvement of farmers. Availability of advisory services. Clear specification and flexibility of the measure (e.g. what crops, proportion of land to be covered).
Reduced fertilisation (*)	Good acceptance if result in cost saving from fertilisers for farmers.	Doubts about the environmental impact. May cause increased costs or other inconveniences. Unclear economic impact.	Availability of advisory and decision-support tools/services.
Buffer strips	Various among farmers. Good acceptance by local population and public.	Much area is taken out of production, income loss (in particular for 20m width buffer strips). Compensation payment is too low to cover the costs. Lack of confidence in estimated effect of nutrients reduction.	Clear specification of the measure. Relevance of informational and decision-support tools to provide clear information for farmers. Compensation payment. Differentiation and effective spatial targeting of the measure (e.g. applied to lands close to water courses). Previous experience with implementing the measure.

Name of measure	General trends on acceptance of measure	The main concerns of farmers	Relevant issues for the acceptance
Constructed wetlands	Rather negative among farmers if affects normal farming. Better if applied in other areas. Good or not known acceptance of local population.	Much arable area is taken out of production, income loss. Costs of construction. Compensation payment is too small. Lack of confidence in effectiveness.	Clear information on the measure. Relevance of informational and decision-support tools. Public funding (for investments in particular). Evidence and explanation on the effectiveness. Awareness of and knowledge on economic gains, multiple effects of the measures and various environmental benefits. Financial incentives (compensation) for participation.

It can be concluded overall that the general trends on acceptance are quite similar in other countries to those indicated for Latvia for various measures. **The main concerns of farmers** in other countries seem to be:

- Foregone income, economic impacts/costs of a measure;
- Compensation is too small;
- Lack of confidence in environmental effectiveness of a measure.

The following **issues** are seen as relevant commonly **for building the acceptance** of farmers (with different relevance for various measures):

- Clear specification and information on measures;
- Early involvement of farmers;
- Availability of advisory services;
- Compensation payments;
- Evidence on environmental effectiveness of measures;
- Knowledge on economic gains, multiple effects and various environmental benefits of measures.

4.14 Certainty in funding availability (C11)

4.14.1 Relevance of the criterion

The relevance assessment of the criterion based on the inquiry of specialists is provided in the next table. It shows that this criterion is commonly highly scored and is ranked among 5 the most important criteria for evaluation and selection of measures.

Table 4.32 Relevance assessment of the criterion based on results of the inquiry of specialists (2013).

Total number of responses – 12. The responses included assessment of each criterion by a scale from 1 "low relevance" to 5 "high relevance" and marking 5 the most important criteria from the listed (11 in total).

No of responses	12
SUM	48
Average	4
No of cases "among 5 the most important"	8
No of scores "4" and "5"	9
Mode (most frequently assigned score)	5
Median (middle of data row)	4.5
Range: Min/Max	1/5
No of scores "1" and "2"	2
Group	Criterion of highest priority

4.14.2 Definition of the criterion used in the study

The certainty in funding availability is seen as low, if possible funding sources are unclear, and high if a funding source/instrument is agreed and there is confidence that the funding will be allocated from there (financial commitment).

For the most measures the funding consists from both private and public funding, in some cases only from the public – EU and/or national/municipal funding.

4.14.3 Assessment of measures using the criterion

Potential funding sources were specified for most 'supplementary' measures in the 1st RBMPs. However this information needs to be reviewed and complemented for the next implementation cycle.

It is commonly recognised that the implementation of 'supplementary' measures will depend highly on public financial support also in the next cycle. In light of the measures for agriculture and forestry the main funding source is the CAP (implemented by the Rural Development Program (RDP) in Latvia). The program for 2014-2020 (incl. funding schemes and potential amount of funding) is under development now. Available information (published for consultations) indicates issues where solutions would be needed to ensure sufficient financial support for implementing the WFD 'supplementary' measures in the next cycle.

The funding schemes of the RDP 2014-2020 that could potentially be discussed in light of funding the WFD 'supplementary' measures (analysed in the study) are highlighted in the next table. As can be seen from the table, further discussions are needed concerning many measures to ensure the necessary financial support for their implementation in the next WFD cycle (marked with light pink colour in the table).

The table 4.34 summarises information on funding sources as specified in the 1st RBMPs and potential funding sources and financial commitments for the next WFD cycle. It includes also assessment on the certainty in funding availability for each measure, which was developed based on the project's expert knowledge using 5-category scale (from "1" being "low" to "5" beng "high" certainty).

Table 4.33 Potential funding schemes of the Rural Development Program (RDP) 2014-2020 for financial support of the WFD 'supplementary' measures in the next cycle.

! NOTE: Only measures where the RDP funding can be seen as a potential funding source are included. Information about the RDP schemes and amount of funding is based on information from draft RDP for public consultations (August of 2013).

Abbreviations: NVZ – Nitrate Vulnerable Zone. Notes: [1] "Ieguldījumi mežu attīstībā un mežu dzīvotspējas pilnveidošanā". [2] "Ieguldījumi meža ekosistēmu noturības un ekoloģiskās vērtības uzlabošanai", "Meža ieaudzēšana". [3] Activity includes 3 sub-activities. Amount of funding based on information from RDP Annex 1 (from 28.06.2013.).

RDP Activities	**Investments in material assets**	**Agro-environment and climate**	**Organic farming**	**Investments in development and improving viability of forests [1]**
Sub-activities		**Promotion of environmentally friendly management**		**Investments in improving resistance and ecological value of forest ecosystems, Propagation of forest [2]**
Indicative funding, million EUR	**478.1**	**64 for the Sub-activity [3] (92.5 for the Activity in total)**	**149.4**	**37 (for the Activity in total incl. both Sub-activities)**
LV1 Arranging environmentally safe manure storage facilities	X			
LV2 Construction of biological WWTP in dairies	X			
LV4 Winter green areas and stubble fields		X (in NVZ) ? (outside NVZ)		
LV5 Green manure		? (other than organic farms)	X (organic farms)	
LV6 Agricultural land buffer zones for: LV6.1 water courses and bodies, LV6.1 drainage systems		X (in NVZ, 3m width, along WB) ? (outside NVZ, above 3m width, along drainage ditches)		
LV7 Good felling practice				?
LV8 Forest buffer zones				?
LV11 Nutrients' retention ponds in AGR drainage systems	?	?		
LV12 Sedimentation ponds to reduce impact of soil erosion from FOR activities	?			?
LV13 Sedimentation ponds to reduce impact of soil erosion from AGR lands	?			
LV14 Sedimentation ponds as part of environment friendly management of FOR drainage systems	X			
LV20 Environment friendly management of FOR drainage systems (LV20.2)				? (for maintenance)
LV21 Environment friendly management of AGR drainage systems (LV21.1 and LV21.2)	X ?	? (for maintenance)		
LV22 Environment friendly management of polder systems	? (for polders in AGR)			

Table 4.34 Funding sources, financial commitments and assessment of the certainty of funding availability for implementing the WFD 'supplementary' measures.

* Based on information from the draft Rural Development Programme (RDP) 2014-2020, version for public consultations (August of 2013). ** Based on information from the Action Program "Growth and Employment" for the EU funds 2014-2020 (2nd version from 25.07.2013.). *** The assessment is developed based on (the project's) expert judgement using 5-category scale from 1 "low" to 5 "high" certainty.

Name of measure	Funding sources as specified in the 1st RBMPs	Comments on potential funding sources and financial commitments for the 2nd WFD cycle.	Assessment (1-5) ***
LV1 Arranging environmentally safe manure storage facilities	Maintenance: private funding. Investment: both private funding and financial support under Rural Development Programme's Axis 1: measure "Modernisation of agricultural holdings".	Similar funding scheme could be available in the next period also.* It should be noted that the public funding rate was rather low in the previous period (40-45%) to be incentive for farmers to implement this measures on a voluntary basis. Possible **funding rate for the next period needs to be clarified**.	3 (uncertainty in private funding)
LV2 Construction of biological WWTP in dairies			2 (uncertainty in private funding)
LV3 Crop fertilisation planning	Private funding and the annual State's support for agriculture and rural development: measure "Support to improve Agricultural land".	Further **availability of public (national) support needs to be clarified.**	4 (if public support is continued)
LV4 Winter green areas and stubble fields	Private funding and also financial support under measure "NATURA 2000 payments" and "payments related to the Directive 2000/60/EK" is possible.	A funding scheme under Activity "Agro-environment and climate" – "Promotion of environmental friendly management" includes payment for this measure. But only for farms in NVZ. * **Public financial support for farms outside NVZ needs to be clarified.**	4 if there is a support scheme 2 without public financial support
LV5 Green manure	Both private funding and financial support: Agri-environment payments "development of organic farming" for farms of organic farming; financial support under measure "NATURA 2000 payments" and "payments related to the Directive 2000/60/EK" for other farms.	The agro-environmental payment for organic farming will be continued in the next RDP also.* For other farms than the organic ones, possible **public financial support scheme needs to be clarified.**	4 with support scheme 2 without support
LV6 Buffer zones in agricultural land (for water courses and bodies; for drainage systems)	Private funding and also financial support - "NATURA 2000 payments" and "payments related to the Directive 2000/60/EK".	**Public financial support needs to be clarified.** A funding scheme under Activity "Agro-environment and climate" – "Promotion of environmental friendly management" includes payment for this measure. **But only for farms in NVZ, along water bodies, 3 m width.*** **Besides, farmers applied for this measure and support on limited extent in the previous period.**	3 with support scheme 1 without support
LV7 Good felling practice	1. Private funding (forest owners); 2. (theoretically) possibility to use financial support under RDP Axis 2: measure "Natura 2000 payments" (for forest owners).	**Financial commitments unclear.** **Possible use of the RDP funding needs to be investigated**. For instance, the funding schemes under Activity "Investments in development and improving viability of forests" – "Investments in improving resistance and ecological value of forest ecosystems", "Propagation of forest".*	4 with support scheme 2 without support
LV8 Forest buffer zones	1. Private funding (forest owners); 2. (theoretically) possibility to use financial support under RDP Axis 2: measure "Natura 2000 payments" (for forest owners).		3 with support scheme 1 without support

Name of measure	Funding sources as specified in the 1st RBMPs	Comments on potential funding sources and financial commitments for the 2nd WFD cycle.	Assessment (1-5) ***
LV9 Research of impact of agricultural activities	State budget (or using EU funding possibilities).	**Funding source(s) need to be specified.**	2
LV10 Research in lakes with unknown reason "at risk"	State budget (or using EU funding possibilities).		1 or 2 (?)
LV11 (AD) Nutrients' retention ponds in AGR drainage systems	Not analysed. Necessary funding and its sources will be estimated after research, when necessary measures for each lake will be specified.	**Funding source(s) need to be investigated.** **Possible public financial support (incl. possible use of the RDP funding) needs to be investigated.**	3 with support scheme 1 without support
LV12 (AD) Sedimentation ponds to reduce impact of soil erosion from FOR activities	(Measure was not proposed in the 1st PoM.)		3 with support scheme 1 without support
LV13 (AD) Sedimentation ponds to reduce impact of soil erosion from AGR lands			3 with support scheme 1 without support
LV14 (AD) Sedimentation ponds as part of environment friendly management of FOR drainage systems	Funding of forest owners. Possibility to use CAP 2007-2013 funding for development and adaptation of AGR and FOR infrastructure.	**Financial commitments need to be clarified.** Uncertainty in private funding (private forests). Possibility to use RDP funding from Activity "Investments in material assets" (75 => 85 % public funding rate if a sedimentation pond is arranged when reconstructing/ renovating drainage system).	4 with support scheme 2 without support
LV15 Improving ecological functionality of lakes	Budget of municipalities or owners/renters of the lake.	Funding source(s) needs to be specified.	4
LV16 Investigation about measures for regulated rivers	Not specified. As an option - LVAF.	**Funding source(s) need to be specified.**	2
LV17 Development of technical provisions for FOR drainage systems	The Forest Development Fund.	**Financial commitment unclear.**	4
LV18 Development of technical provisions for AGR drainage systems	The annual State's support for agriculture and rural development: measure "Support for science and education."		4
LV19 Development of technical provisions for polders			4
LV20 Environment friendly management of FOR drainage systems (LV20.2)	Funding of forest owners. Possibility to use CAP 2007-2013 funding for development and adaptation of AGR and FOR infrastructure.	**Financial commitments need to be clarified.** [For LV20.2 (maintenance)] Funding of drainage systems' owners. Uncertainty in private funding (private forests). Possible public financial support (e.g. RDP funding from Activity "Investments in development and improving viability of forests") needs to be investigated.	3 with support scheme 1 without support

Name of measure	Funding sources as specified in the 1st RBMPs	Comments on potential funding sources and financial commitments for the 2nd WFD cycle.	Assessment (1-5) ***
LV21 Environment friendly management of AGR drainage systems (LV21.1 and LV21.2)	Funding of farmers. Possibility to use CAP 2007-2013 funding for development and adaptation of AGR and FOR infrastructure.	**Financial commitments need to be clarified.** [For LV21.1] Uncertainty in private funding. Possibility to use RDP funding from Activity "Investments in material assets". [For LV21.2] Funding of drainage systems' owners. Uncertainty in private funding. Possible public financial support (e.g. RDP) needs to be investigated.	3 with support scheme 1 without support
LV22 Environment friendly management of polder systems	According to the National program for flood risk management 2008-2015: ERDF (Act. "Reducing environmental risks" 2007-2013); the State and municipal budgets.	**Financial commitments need to be clarified.** Possible funding sources: (1) RDP Act. "Investments in material assets" for polders in relation to agriculture (in rural areas)? (2) ERDF and national co-funding (Action Program "Growth and Employment" for the EU funds 2014-2020, Thematic objective 5 "Supporting adaptation to climate change, risk prevention and management").	4 with support scheme 2 without support
LV23 Development of RB Management Information system	ERDF (Act. "Development of information systems and electronical services"; project "Development of joint environmental information system"). LVĢMC/State (current) budgets.	It is unclear if further funding would be required.	2
LV24 Educational and Informational measures	ERDF (Act. "Development of information systems and electronical services"; project "Development of joint environmental information system"). LVĢMC/State (current) budgets.	**Funding source(s) needs to be specified.** Possible use of RDP funding in relation to implementing the measures for agriculture and forestry (RDP Activities "Knowledge transfer and informational measures" and "Consultancy services").*	3
LV25 Organising public participation	Budgets of LVĢMC and VARAM.	(Financial commitments need to be clarified.)	4
LV26 (AD) Improving ecological processes when maintaining regulations of rivers	NA. Necessary funding and its sources will be estimated after the investigation (LV16) when the measures would be specified.	**Funding source(s) and financial commitments need to be clarified.** **Private funding, but public financial support would also be needed** (possible use of the RDP?).	3 with support scheme 1 without support
LV27 (AD) Improving ecological functionality of regulated rivers by naturalisation of river bed		**Funding source(s) need to be investigated and financial commitments clarified.** **Public financial support is needed** (possible use of LIFE, other "nature" funding?).	2
LV28 (AD) Management of Protected belts of water courses/bodies	(Measure was not proposed in the 1st PoM.)	**Funding source(s) need to be investigated and financial commitments clarified.** **Public financial support could be needed.**	3 with support scheme 1 without support

4.14.4 Relevant gaps for future work

Implementation of majority of the measures (the "technical" measures in particular) will depend on the public financial support. It is important task for the next RBMPs **to clarify sources of public support funding (incl. payment schemes)**. This is important to implement further/maintain the on-going measures (like agricultural buffer zones and winter green areas), to start implementation of the measures with deadline in the 1st WFD cycle (like forest buffer zones and Good Felling Practice), and also to ensure implementation of the "technical" measures that should be specified after research (e.g. lake protection measures). The priorities, actions, schemes and amounts of EU funding for period 2014-2020 will become clear to the beginning of 2014. The current consultation period (e.g. concerning the public funding for agriculture) can be used to ensure that the WFD needs are taken into account.

In some cases attention should be paid also on **optimal level of public financial support** that it would provide incentive to implement the measures on voluntary basis. Previous experience (for instance, concerning arrangement of manure storage facilities and establishing buffer zones in agricultural lands) indicates that it can affect success of implementation of the measures.

Important task is **to specify (and secure) funding for the research and regulatory measures that are necessary to specify further "technical" measures.** The measures LV10, LV16 and LV17-19 should be noted in particular (with deadline of implementation December of 2014 and December of 2012 respectively). The follow-up "technical" measures (incl. their potential funding sources) could be specified fully only after results from these measures are available.

As can be seen from the previous table, **certain specifications on funding sources and/or financial commitments for the next WFD cycle are needed for all the measures.** These issues should be addressed when working on the next RBMPs.

5 Economic evaluation and prioritisation of the measures

The approach proposed in this study aims to demonstrate the multi-criteria assessment and evaluation of measures to substantiate prioritisation and selection of measures for the WFD programs of measures. Two ways of applying the multi-criteria evaluation were explored – a semi-quantitative and quantitative multi-criteria evaluation of the measures.

The semi-quantitative evaluation approach considers socioeconomic "efficiency categories" for evaluation of the measures (see the table below). For each measure an average score is calculated from the individual scores for the criteria (with the common 5-category scale where the general interpretation is from "1"being "very low" to "5" being "very high"[40]). The average score for a measure is interpreted in terms the efficiency category according to the scoring as shown in the table below. For instance, if the average score for a measure from all the criteria is below "3" (which is lower than "moderate" in the used 5-category scale), a measure has low socioeconomic efficiency. If the average is above 3.5 a measure has high efficiency.

Table 5.1 Explanation of the "efficiency categories" used for the evaluation of the measures based on the semi-quantitative approach.

Explanation of Categories	Scores
Low efficiency	< 3
Neutral efficiency	3 – 3.5
High efficiency	3.5 – 5

The quantitative evaluation approach builds on the individual scores of the criteria (from 1 to 5), and a total score for each measure is calculated as sum of these individual scores. In addition, weights are used for each criterion according to the inquiry of specialists (the average relevance assessment of each criterion from the inquiry). The measures are afterwards ranked based on these total scores where the most efficient is the measure with the highest score and the least efficient is the one with the lowest score.

Such total scores and ranks were calculated for (i) the cost-effectiveness assessment only (C1), (ii) the "priority" criteria according to the inquiry (C1, C3, C8, C10, C11), (iii) all the criteria. For the latter case, due to information gaps the individual scores could not be developed for the C5 and C6 (on administrative costs and indirect costs and wider negative socioeconomic impacts). These criteria are considered in the evaluation in a qualitative way, where "-" (minus) is accounted in case a measure has high administrative costs or potential negative distributional impact (see the chapters 4.8 and 4.9 for more information).

The three ranks are compared to analyse differences in prioritisation of the measures when including various criteria in their evaluation (e.g. the cost-effectiveness assessment versus assessment using all criteria).

The evaluation and prioritisation of the measures was carried out separately for the nutrients' pollution problem (see the chapter 5.1) and the hydro-morphological pressures (see the chapter 5.2).

[40] See the chapter 4.3 for a summary on specification of the categories for each criterion and individual chapters for each criterion in the section 4 for more detailed information.

5.1 Evaluation and prioritisation of measures for reducing nutrients' pollution

Only measures with direct effect (in terms of reducing pressures or improving the state) were included in the evaluation.[41] 19 "technical" measures from the analysed have such effect in relation to the nutrients' pollution (either by the "targeted effect" or by the multiple effects of a measure). Two of them address specific environmental situations (LV15 "Improving ecological functionality of lakes" and LV28 (AD) "Management of the Protected Belts of water courses/bodies"), besides they lack assessments for many criteria. Thus, 17 measures addressing the pressures from agriculture and forestry were included in the evaluation.

The next table summarises the individual assessment scores for all the measures with all the applied criteria, which were used as basis for calculating summary assessments with both evaluation approaches. In order to derive the summary assessments the missing values (with the assessments "NK" due to lack of information) were filled in. It was done based on expert judgement, which built on developing interval values and applying a sensitivity analysis to account uncertainty in such assessments. The initially missing values that were filled in later are shown in the table in brackets []. Also in cases where the initial scores included some kind of intervals (e.g. different load reduction efficiency of a measure concerning N and P), these intervals were taken into account when calculating the summary scores.

[41] The research, informational and regulatory & administrative measures, which don't have direct effect on the water environment, are not included.

Table 5.2 Assessments for the "technical" measures reducing nutrient pollution from agriculture and forestry – the individual scores for all the applied criteria.

Notes: C2 is not included, since it was not analysed in the study. The common interpretation of the assessment scores is from 1 "very low" to 5 "very high". Scores in brackets [x] marks cases where the assessments were initially missing and were filled in for the evaluation based on expert judgement. Only the ("technical") measures with direct effect (in terms of reducing nutrient pollution) are included. The light green colour in the first column marks the measures where the nutrients' reduction is the "targeted effect" of a measure (otherwise it is due to multiple effects of a measure).

[1] The cost-effectiveness (CE) assessment considering direct effect and the 'financial costs'. [2] The certainty of the effectiveness' assessment for each measure was developed concerning its "targeted effect" (water quality element). For those measures where reducing nutrients' pollution is due to their multiple effects certainty in relation to these effects' assessments should be used instead (was not assessed in this study). [3] With/without public financial support. [4] The missing assessments were completed based on the following approach: the effectiveness' assessment was available, an interval based on expert judgement was assumed for the costs' assessment, the CE is estimated based on these scores like for other measures (using the matrix presented in the chapter 4.4.4.1).

Name of measure	Targ. activ.	(C1) CE [1] - NUTRIENTS	Other "priority" criteria				"Important" criteria				
		Score	(C3) Multiple effects	(C8) Env. benefits	(C10) Stakeholder acceptance	(C11) Certainty in funding	(C7) Certainty in Effect and Costs [2]	(C9) Enforcm. schemes	(C4) Econom. costs	(C6) Wider negative impacts (DI)	(C5) Admin. Costs
LV1 Arranging environmentally safe manure storage facilities	AGR	3	1	3	3	3	2	4	5	-	+
LV2 Construction of biological WWTP in dairies	AGR	4-3	1	2	3	2	3	3	5	-	
LV3 Crop fertilisation planning	AGR	3	1	2	4-3.5	4	2	4	5	-	
LV4 Winter green areas and stubble fields	AGR	4	1	3	4-3.5	4 or 2 [3]	2	4	5	-	
LV5 Green manure	AGR	2	1	2	4-3.5	4 or 2 [3]	3	4	5	-	
LV6.1 Agricultural land buffer zones for water courses and bodies	AGR	5-3	3	4	4 or 2 [3]	3 or 1 [3]	2	4-3	3	-	-
LV6.2 Agricultural land buffer zones for drainage systems	AGR	3	3	4	[4-2] [3]	3 or 1 [3]	2	1	4-4.5	-	-
LV7 Good felling practice	FOR	5-4.5	3	3	3	4 or 2 [3]	1	3	3	-	-
LV8 Forest buffer zones	FOR	5-4	3	3	2	3 or 1 [3]	3	3	5	-	-
LV11 (AD) Nutrients' retention ponds in AGR drainage systems	AGR	3-1	3	4	[4-2]	3 or 1 [3]	1	1	4	-	-
LV12 (AD) Sedimentation ponds to reduce impact of soil erosion from FOR activities	FOR	4	4	3	[4-2]	3 or 1 [3]	3	1	5	-	-
LV13 (AD) Sedimentation ponds to reduce impact of soil erosion from AGR lands	AGR	4	4	3	[4-2]	3 or 1 [3]	4	1	5	-	-

Name of measure	Targ. activ.	(C1) CE [1] - NUTRIENTS	Other "priority" criteria				"Important" criteria				
		Score	(C3) Multiple effects	(C8) Env. benefits	(C10) Stakeholder acceptance	(C11) Certainty in funding	(C7) Certainty in Effect and Costs [2]	(C9) Enforcm. schemes	(C4) Econom. costs	(C6) Wider negative impacts (DI)	(C5) Admin. Costs
LV14 (AD) Sedimentation ponds as part of environment friendly management of FOR drainage systems	FOR	4-3	4	3	[4-2]	4 or 2 [3]	4	3	5	-	-
LV20 Environment friendly management of FOR drainage systems [LV20.2]	FOR	[3-2] [4]	4-3	3	[4-2]	3 or 1 [3]	[3-2]	2	5	[-]	-
LV21 Environment friendly management of AGR drainage systems [LV21.2]	AGR	[3] [4]	4	5	[4-2]	3 or 1 [3]	[3-2]	2	4-4.5	[-]	-
LV 26 (AD) Improving ecological processes when maintaining regulations of rivers	AGR	[3] [4]	4	4	[4-2]	3 or 1 [3]	[3-2]	1	5	[-]	-
LV27 (AD) Improving ecological functionality of regulated rivers by naturalisation of river bed	AGR	[3] [4]	4	4	[4-2]	2	[3-2]	1	5	[+]	-

The next table shows results from both approaches – the calculated ranks of the measures based on the quantitative approach and the "efficiency categories" of the measures based on the semi-quantitative approach. The results are explained after the table.

Table 5.3 Ranks and "efficiency categories" of the measures for reducing nutrients' pollution based on the multi-criteria evaluation approach.

R3 – ranks of the measures based on the quantitative approach using all criteria.

R2 – ranks of the measures based on the quantitative approach using the "priority" criteria (C1, C3, C8, C10, C11).

R1 – ranks of the measures based on the quantitative approach using the CE (C1) as criterion only.

Ch – Changes in the rank of a measure comparing R3 to R1.

EffCat_All/Prior – semi-quantitative evaluation with "efficiency categories" based on using all/"priority" criteria.

Name of measure	Targ. Activ.	R3	R2	R1	Ch	EffCat _All	EffCat _Prior
LV14 (AD) Sedimentation ponds as part of environment friendly management of FOR drainage systems	FOR	1	3	8	↑	3.6	3.3
LV4 Winter green areas and stubble fields	AGR	2	10	3	→	3.2	3
LV13 (AD) Sedimentation ponds to reduce impact of soil erosion from AGR lands	AGR	3	6	6	↗	3.3	3.2
LV21 Environment friendly management of AGR drainage systems [LV21.2]	AGR	4	1	12	↑	3.2	3.4
LV8 Forest buffer zones	FOR	5	11	2	↓	3.2	2.9
LV27 (AD) Improving ecological functionality of regulated rivers by naturalisation of river bed	AGR	6	8	14	↑	3.1	3.2
LV12 (AD) Sedimentation ponds to reduce impact of soil erosion from FOR activities	FOR	7	5	5	→	3.1	3.2
LV3 Crop fertilisation planning	AGR	8	14	10	→	3.1	2.8
LV6.1 Agricultural land buffer zones for water courses and bodies	AGR	9	4	4	↓	3.1	3.2
LV 26 (AD) Improving ecological processes when maintaining regulations of rivers	AGR	10	7	13	↗	3.1	3.2
LV1 Arranging environmentally safe manure storage facilities	AGR	11	15	9	→	3.0	2.6
LV7 Good felling practice	FOR	12	2	1	↓	3.0	3.4
LV5 Green manure	AGR	13	16	16	↗	3.0	2.4
LV20 Environment friendly management of FOR drainage systems [LV20.2]	FOR	14	13	15	→	2.9	2.8
LV2 Construction of biological WWTP in dairies	AGR	15	17	7	↓	2.8	2.3
LV6.2 Agricultural land buffer zones for drainage systems	AGR	16	9	11	↓	2.8	3.0
LV11 (AD) Nutrients' retention ponds in AGR drainage systems	AGR	17	12	17	→	2.5	2.8

The ranking of the measures using all the criteria is used for the prioritisation of the measures (the measures are ranked in the table according to this rank (R3)).

Comparing the ranks based on all the criteria (R3) and based on the "priority" criteria (R2) shows that the rank values often differ for the same measure. When comparing the "top measures" (to the 9th rank position – the middle of the measures' list) of both ranks, the following measures have different positions in terms of belonging to the "top measures" or not (being above/below the 9th rank position, see the measures marked with yellow colour in R2 column):

- LV3 and LV4 – they have high score for C9 "Availability of enforcement schemes" improving their rank value in R3;
- LV8 – it has relatively good score for C7 "Certainty of the effectiveness and costs' assessments" and very high score for C4 "Economic costs" improving its rank value in R3;
- LV26 (AD) – it has very low score for C9 "Availability of enforcement schemes" reducing its rank value in R3;
- LV7 – it has very low score for C7 "Certainty of the effectiveness and costs' assessments" and moderate score for C4 "Economic costs" (what means high costs comparing to the most measures) reducing its rank value in R3;
- LV6.2 – it has low score for C7 "Certainty of the effectiveness and costs' assessments" and very low score for C9 "Availability of enforcement schemes" reducing its rank value in R3.

This result demonstrates **impact of other than the "priority" criteria (C7, C9 and C4) on prioritisation of measures**.

Difference between the approaches for evaluation and prioritisation of measures based on the cost-effectiveness (CE) versus multi-criteria assessment is demonstrated by **difference between the ranks R1 (based on the CE only) and R3 (based on all the criteria)**. Comparison of both rankings shows large differences in rank positions for many measures:

- The first two measures in the CE rank (R1) are only on the 5th and 12th position in the rank R3 (using all the criteria). LV7 "Good felling practice" has moved from the 1st position in the CE rank to the 12th position in R3 (which is even out of "top (9) measures"). This is, in particular, due to very low certainty in effectiveness and costs' assessments (for C7), but also due to limited ("moderate") multiple effects and benefits (C3 and C8). For LV8 "Forest buffer zones" the CE rank is reduced by low stakeholders acceptance and certainty in funding availability (C10 and C11).
- LV2 "Construction of biological WWTP in dairies" has moved from "top 9" measures' list based on the CE rank to the 15th position in R3. This is due to low scores for all other "priority" criteria besides the CE (C3, C8, C10, C11).
- Also both measures on agricultural land buffer zones (LV6.1 and LV6.2.) have considerably lower rank positions in the rank R3, which is due to low certainty in the effectiveness and costs' assessments, limited stakeholders' acceptance and certainty in funding availability.
- 4 newly added measures have considerably better ranking in R3 than in the CE rank. These are LV14 (AD) (from 8th position in R1 to 1st position in R3), LV13 (AD) (from 6th position to 3rd position), LV21 (from 12th position to 4th position), LV27 (AD) (from 14th position to 6th position). They all belong to the "top 9" measures when ranked using all the criteria. The high positions are due to high multiple effects and benefits (C3 and C8) and good scores for the 'economic costs' (C4), as well as high assessment for certainty in the effectiveness and costs' assessments for LV13 and LV14. This demonstrates that the measures added by the study are efficient alternatives to be considered for the RBMPs.

LV4 "Winter green areas and stubble fields" has similarly high position in both ranks. LV1, LV5 and LV11 (manure storage facilities, green manure and nutrients' retention ponds) have relatively similar low rank positions in both ranks. The same applies to LV26 (AD) and LV20.

The light pink colour in the 1st column of the table marks those measures that are included in the ECOLAS model, which was used for the cost-effectiveness analysis of the nutrients' pollution reduction measures for prioritisation and selection of the 'supplementary measures' for the 1st RBMPs. As can be seen, only 8 measures from the analysed in this study are included in this model. Moreover, half of them are not in the "top (9) measures" list when using the multi-criteria evaluation approach for the prioritisation of measures. This and the results discussed above

demonstrate **limitations that the (ECOLA) model puts for identifying efficient measures and significant differences in the evaluation results when using the multi-criteria approach instead of the CE assessment only**.

When comparing the results from the **quantitative and semi-quantitative multi-criteria evaluation**, they show similar prioritisation overall. The last two columns in the table show the semi-quantitative evaluation results in terms of the "efficiency categories" (High/Neutral/Low efficiency) for each measure. They are calculated using all or "priority" criteria. As can be seen, only one measure has "high" "efficiency category" – LV14 (AD) "Sedimentation ponds as part of environment friendly management of FOR drainage systems". 4 measures have "low" "efficiency category" and all other "neutral" "efficiency category".

The **advantage of the semi-quantitative approach is that the scores show the efficiency of measures in "absolute" terms – according to the scale used for the assessment (from 1 meaning "very low" to 5 meaning "very high").** The main disadvantage is that it gives limited possibilities for prioritisation (ranking) of measures, since the measures have very similar categories and scores. **In case with many alternatives (measures) the quantitative approach allows better comparison and prioritisation (ranking) of the measures.** It also allows **incorporating importance of the various criteria** (by using the weights). At the same time it might require better information base for developing more reliable assessments if the scores are used for ranking of measures.

The most socioeconomically efficient measures for reducing nutrients' pollution, according to the used quantitative evaluation and prioritisation of measures using all the criteria are the sedimentation ponds for forest and agricultural lands (LV14 (AD) and LV13 (AD)), environment friendly management of agriculture drainage systems (LV21.2), winter green areas and stubble field (LV4), as well as forest buffer zones (LV8).

It needs to be noted that **almost half of the "top (9) measures" allow reducing the nutrients' pollution due to their multiple effects** (nutrients' pollution is not their "targeted effect"). These are measures LV12, LV13, LV14, LV27 (AD). They aim to address hydro-morphological pressures, but have also relatively good nutrient reduction efficiency, which combined with low costs gives good cost-effectiveness. **The aspect of the multiple effects of measures due to which there are measures addressing hydro-morphological pressures and being (cost-)effective for reducing nutrients' pollution also is not accounted in the 1st RBMPs when evaluating and selecting measures.**

The least efficient measures are nutrients' retention ponds (LV11 (AD)) and environment friendly management of forest drainage systems (LV20.2), construction of biological WWTP in dairies (LV2), green manure (LV5) and agricultural land buffer zones for drainage systems (LV6.2). It could be noted that two other measures that are included in the RBMPs – LV1 on manure storage facilities and LV7 on Good Felling Practice (proposed in the 1st RBMPs for few WBs and around 10 WBs respectively), also have rather low socioeconomic efficiency based on the multi-criteria evaluation.

It needs to be stressed that the results presented above should be viewed with caution due to the poor information base for developing the assessments of measures. This study aimed to gather the available information and test the proposed (multi-criteria) assessment approach. It also provides relevant messages concerning the results for economic evaluation and prioritisation of the measures (as discussed above), however the exact scores and rankings should be taken as rough overall. **In order to obtain more reliable evaluation results the information base needs to be improved considerably first of all, but also the methodological approach needs to be applied in more refined manner** (for instance, by refining used assumptions and testing interval values for calculating various summary scores and categories and performing sensitivity analysis of the results).

5.2 Evaluation and prioritisation of measures for reducing hydro-morphological pressures

Like for the nutrients' pollution problem, only measures with direct effect were considered in the evaluation also here. 15 "technical" measures in total address the water quality problems caused by hydro-morphological pressures (either by the "targeted effect" or by multiple effects of a measure). LV22 was not included since it lacked assessments for almost all the criteria.

Due to lack of the assessments for many measures for range of the criteria, the multi-criteria assessment approach couldn't be tested fully. Those criteria where the assessments could be developed for all the measures were considered. At the end the following criteria could be applied for the evaluation of the measures:

- Effectiveness assessment of measures, which is only part of C1, instead of the cost-effectiveness assessment (CE). The CE assessment requires also assessment for the (financial) costs. But it was lacking for many measures.
- All other "priority" criteria except C10 on stakeholders' acceptance, for which the assessments were lacking for many measures (C3 on multiple effects, C8 on benefits and C11 on certainty in funding availability are included).
- C7 on certainty of the effectiveness' assessment from the group of "important criteria", since the assessments were developed for all measures only for this criterion.

As can be seen from the list above, **the criteria on economic assessments (e.g. various types of the costs) couldn't be taken into account. There are large information gaps for the assessments of the measures targeting hydro-morphological pressures, in particular, for the newly specified and added measures and all types of their costs (incl. the 'financial costs').** Due to this reason the result is more illustrative for using the approach than practically applicable in terms of the evaluation of the measures.

It should be noted concerning the effectiveness assessment that for each measure a joint effectiveness score in relation to all hydro-morphological quality elements (concerning the hydrology, continuity and morphology) is used. All the measures can affect the morphology (sediments), but part of the measures can affect also other elements.[42] In such cases the individual scores for each element built an interval for the "total" effectiveness score. If the measures want to be evaluated for specific hydro-morphological pressure/problem in connection to specific water quality element (e.g. hydrological regime), the individual scores for this element can be used instead (considering the measures that affect the given element). In the given case, due to information limitations and the aim of illustrating use of the approach the efficiency of measures for hydro-morphological pressures overall were evaluated.

The next table shows the results from both approaches – the calculated ranks of the measures based on the quantitative approach and the "efficiency categories" of the measures based on the semi-quantitative approach.

The scores and categories for the semi-quantitative evaluation should be viewed as illustrative only. Using the effectiveness assessment instead of the cost-effectiveness assessment gives higher scores overall. The CE score is combination of the effectiveness and the costs scores and in terms of numerical values it is commonly lower than the effectiveness score.

[42] See the Annex 4 for the assessments of environmental (water-related) effects of the measures.

Table 5.4 Ranks and "efficiency categories" of the measures for reducing hydro-morphological pressures based on (partial) multi-criteria evaluation.

R1 – ranks of measures based on the quantitative approach using the effectiveness' assessment of measures (part of C1) as criterion only. The costs are not considered since the assessments were lacking for many measures.

R2 – ranks of measures based on the quantitative approach using the "priority" criteria for which the assessments were available (Effectiveness part of C1, C3, C8 and C11). C10 on stakeholders' acceptance is not included since the assessments were lacking for many measures.

R3 – ranks of measures based on the quantitative approach using the "priority" criteria and C7 from the group of "important criteria".

Ch – Changes in the rank of a measure comparing R3 to R1.

EffCat_All/Pr – semi-quantitative evaluation with "efficiency categories" based on using the analysed all/"priority" criteria.

	Name of measure	Targeted activity	R3	R2	R1	Ch	EffCat _ All	EffCat _ Pr
LV28 (AD)	Management of Protected Belts of water courses/bodies	OTH	1	1	1	→	4.1	4.1
LV15	Improving ecological functionality of lakes	OTH	2	2	2	→	3.6	4.0
LV21	Environment friendly management of AGR drainage systems [LV21.2]	AGR	3	3	4	→	3.5	3.6
LV27 (AD)	Improving ecological functionality of regulated rivers by naturalisation of river bed	AGR	4	4	3	→	3.3	3.4
LV14 (AD)	Sedimentation ponds as part of environment friendly management of FOR drainage systems	FOR	5	6	10	↑	3.3	3.1
LV26 (AD)	Improving ecological processes when maintaining regulations of rivers	AGR	6	5	5	→	3.2	3.3
LV13 (AD)	Sedimentation ponds to reduce impact of soil erosion from AGR lands	AGR	7	10	9	↗	3.1	2.9
LV6.1	Agricultural land buffer zones for water courses and bodies	AGR	8	7	6	↘	2.9	2.9
LV6.2	Agricultural land buffer zones for drainage systems	AGR	9	8	7	↘	2.9	2.9
LV12 (AD)	Sedimentation ponds to reduce impact of soil erosion from FOR activities	FOR	10	9	8	↘	2.9	2.9
LV11 (AD)	Nutrients' retention ponds in AGR drainage systems	AGR	11	11	14	↗	2.7	2.6
LV20	Environment friendly management of FOR drainage systems [LV20.2]	FOR	12	12	12	→	2.7	2.6
LV8	Forest buffer zones	FOR	13	14	11	↘	2.6	2.5
LV7	Good felling practice	FOR	14	13	13	→	2.3	2.6

Since R2 and R3 differ only by one criterion – C7 on certainty of the effectiveness assessment, the results of both ranks are very similar. The exception is the measure LV13 (AD), which has better rank in R3 due to relatively high certainty of the effectiveness assessment.

The high assessment for LV28 (AD) is due to high effectiveness of the measure. However it is the case when the problem addressed by the measure exists in reality (lack of management of the Protected Belt). Without such a problem the effectiveness and, accordingly, also the summary assessments would be lower. Specific sources of the hydro-morphological problems are

addressed also by the measure LV15, which doesn't relate directly to reducing pressures from agriculture and forestry.

Comparison of R1 (based on the effectiveness only) and R3 (base on all included criteria) shows some differences in the rank positions of the measures.

- LV 14 (AD) on sedimentation ponds as part of environment friendly management of forest drainage systems has considerably higher position in R3 than R1 due to high multiple effects and certainty in the effectiveness assessment.
- LV 13 (AD) on sedimentation ponds to reduce impact of soil erosion from agricultural lands has slightly higher position in R3 due to the same reasons as LV14 (AD).
- LV12 (AD) on sedimentation ponds to reduce impact of soil erosion from forestry activities and agricultural land buffer zones (LV6.1 and LV6.2) has slightly lower positions in R3 due to moderate multiple effects or benefits and certainty of the effectiveness' assessment. At the same time their overall position in the rank is rather similar.

The top 4 measures are the same in all the ranks. And also the least efficient measures are the same – LV7, LV8 LV11 and LV20.2. This can be explained partly by the fact that R3 incorporates limited list of additional criteria and is based largely on the effectiveness assessment.

The most efficient measures according to the used quantitative evaluation with all the included criteria, besides the LV28 (AD) and LV15 (both targeted to specific cases of the hydro-morphological problems), are the environment friendly management of agricultural drainage systems (LV21.2), improving ecological functionality of regulated rivers by naturalisation of river bed (LV27 (AD)) and sedimentation ponds as part of environment friendly management of forest drainage systems (LV14 (AD)). The least efficient measures are Good Felling Practice (LV7) and forest buffer zones (LV8), environment friendly management of forest drainage systems (LV20.2) and nutrients' retention ponds (LV11). These measures, except LV20.2, affect the hydro-morphology by their multiple effects (since nutrients are their "targeted effect").

However, as noted, **the result should be seen more as illustration for using the approach than practically applicable result in terms of the evaluation of the measures**.

6 Summary on information provision and gaps for applying the proposed approach

Detailed assessments of information gaps for future work are presented in the section 4 at the end of the chapters for each criterion. This section aims to summarise the main results and lessons in light of the information provision for the economic assessment of the measures and possible application of the proposed approach for the next WFD cycle.

The next figure shows for each of the applied criteria[43] a proportion of the measures where the assessments could and could not be developed ("assessed" and "not assessed" measures). The lack of the assessments is due to lack of information for their development.

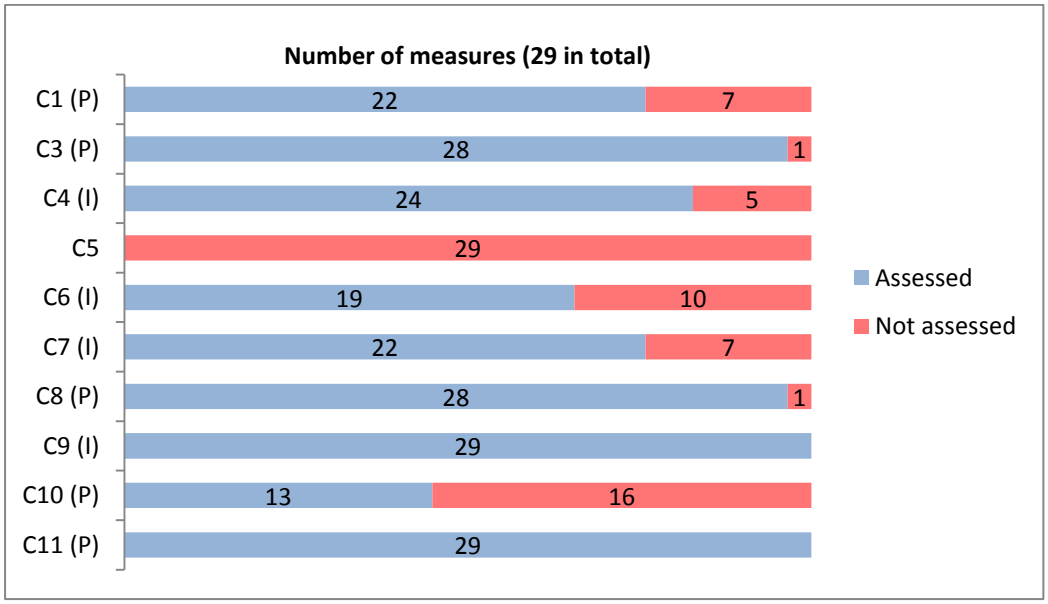

Figure 6.1 Proportion of assessed and not assessed measures under each applied criterion[44].

Note: The total number of the measures is 29 since the two sub-measures for agricultural buffer zones (LV6.1 and LV6.2) are accounted separately.

For each criterion on the vertical axis, its importance category (based on the inquiry of specialists) is shown in brackets, where "P" marks the criteria with the highest priority and "I" marks important criteria.

The assessments could be developed for all the measures for the **criteria 9 and 11** ("Availability of enforcement schemes for implementing a measure" and "Certainty in funding availability"), and practically for all measures also for the **criteria 3 and 8** ("Multiple effects of a measure" and "Socioeconomic benefits from environmental improvements"). For the two latter the assessments couldn't be developed only for the measure LV22 "Environment friendly management of polder systems", for which the actual measures are not specified yet. 3 of the criteria above belong to the 5 most priority ones.

[43] An exception is the criterion 2 ("Time until effect after making a measure operational"), which was not applied due to limitations of the study and also its relatively lower relevance.

[44] C1 "Cost-effectiveness of a measure", C3 "Multiple effects of a measure", C4 "Economic costs of a measure", C5 "Administrative costs of implementing a measure", C6 "Indirect costs and wider negative socioeconomic impacts", C7 "Certainty in the effectiveness and costs' assessments of a measure", C8 "Socioeconomic benefits from environmental improvements", C9 "Availability of enforcement scheme(s) for implementing a measure", C10 "Acceptance by stakeholders concerned by implementing a measure", C11 "Certainty in funding availability".

Concerning the benefit assessments, it should be stressed that although the measures have been assessed, the developed assessments are very rough and should be viewed with caution. There are important gaps for future work to develop reliable assessments (more information is provided in the chapters 4.11.3 and 4.11.4).

The assessments could be developed for more than 80 % of measures for the **criterion 4** ("Economic costs of a measure"). Only 5 measures could not be assessed due to lack of information for unspecified or new measures (LV15, LV20, LV(AD)26-28). However the assessments are rather rough that with the current information base this criterion could be used for evaluation of the measures with sufficient reliability.

Lack of the assessments for the **criteria 1 and 7** ("Cost-effectiveness of a measure" and "Certainty in the effectiveness and costs' assessment") are caused by lack of the assessment on 'financial costs' of the measures. Two measures (LV15 and LV22) are not enough specified yet that the costs could be assessed. For the other, the available information was not sufficient to develop the assessment (LV20-21, LV(AD)26-28).

Concerning the cost-effectiveness assessments, it should be stressed that, although around 75 % of the measures have been assessed, the certainty of these assessments is too low majority of the "technical" measures (see the figure below). It is related to specification of the measures, location/case-specific variations in the effectiveness and costs, which can't be accounted sufficiently with the current information base, and lack of information on the costs of the measures. This indicates need for considerable work to improve the information base for the cost-effectiveness assessment, in particular taking into account the relevance of this criterion.

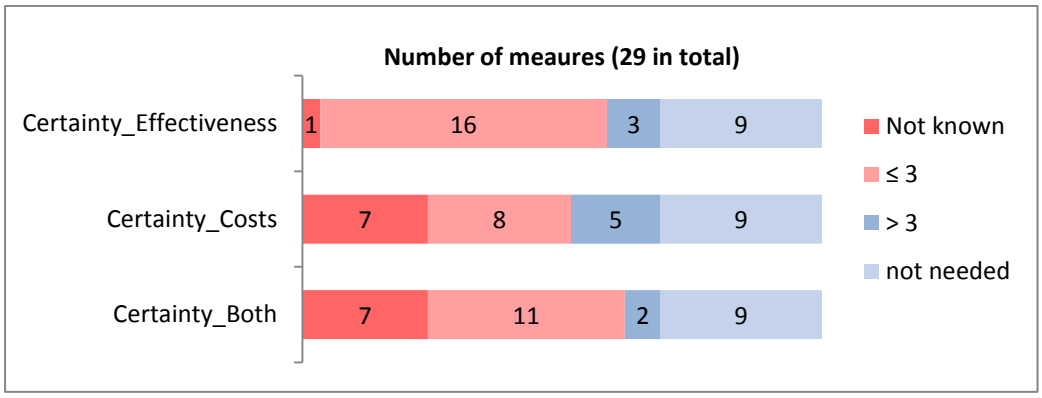

Figure 6.2 Distribution of the measures by certainty categories for the certainty of the effectiveness and costs' assessments.

Note: "Certainty_Both" is combined assessment for the criterion where certainty for both – the effectiveness and costs' assessments are considered together.[45] "Not known" where the certainty couldn't be assessed and "≤ 3" where the certainty is too low[46]. "> 3" where the certainty can be seen as acceptable. "Not required" includes cases where a measure doesn't have direct effect, thus the effectiveness is not estimated and the certainty assessment not developed.

The assessments could be developed for more than 60 % of the measures for the **criterion 6** ("Indirect costs and wider negative socioeconomic impacts"). But it should be stressed that the available information allowed only rough qualitative assessment and indication of measures with possibly high distributional impacts. 10 measures could not be assessed at all due to lack of the

[45] For combining the certainty assessments for both the worst of the two assessments is used. The cost-effectiveness is estimated based on the effectiveness and costs' assessments. If the certainty of any of these assessments is low, also the total certainty assessment is low.

[46] 5-category assessment scale is used: 1 "very low", 2 "low", 3 "moderate", 4 "high", 5 "very high" certainty.

assessment on "direct" socioeconomic impacts of the measures (the 'financial costs' and 'economic costs' in particular), since the wider impacts of a measure arise from the "direct" economic impacts.

Less than half of the measures could be assessed for the **criterion 10** ("Acceptance by stakeholders concerned by implementing a measure"). There is significant lack of information about the stakeholders' acceptance of many measures, besides not only the new ones added by this study, but also for those included in the 1st RBMPs. This information gap needs to be filled in the future taking into account the relevance of this criterion.

Available information was not sufficient for developing assessments for the **criterion 5** ("Administrative costs of implementing a measure"). Only types of the costs were analysed and the measures with possibly high administrative costs are indicated. Although the criterion is not seen among the priority ones, the information base needs to be improved to account them (even in a simple qualitative way) in the economic evaluation of the measures.

The next figure illustrates the lack of the assessments by the measures – for each measure a proportion of the criteria where the assessments could and could not be developed is shown ("assessed" and "not assessed" respectively).

The measures with the most missing assessments are:

- LV22 "Environmental friendly management of polder systems", where actual measures are not yet specified thus their effects/impacts could not be assessed;
- the newly added measures LV26-28 on improving ecology of straightened rivers and management of the Protected Belts, where the assessments for 4 criteria only could be developed (C3 on multiple effects, C8 on benefits, C9 on enforcement schemes and C11 on certainty in funding availability), and lack of information about (all types of) the costs is the reason for majority of missing assessments;
- LV15 "Improving ecological functionality of lakes", LV20 and LV21 on environment friendly management of forest and agricultural drainage systems, where the assessments couldn't be developed for half of criteria mainly due to lack of information on costs.

There are relatively few missing assessments for the **measures addressing nutrient pollution as the "targeted problem"** – for majority of such measures the assessments could not be developed at all for two criteria only (C5 and C10 on the administrative costs and stakeholders' acceptance), except LV15 and LV21.

Concerning the **measures addressing hydro-morphological alterations as the "targeted problem"**, for 7 out of all (12) also only the assessments for C5 and C10 could not be developed (for the newly added measures on sedimentation ponds and research and administrative measures without direct effect). For considerable part of the measures (LV20, LV22, LV26-28) half or more assessments could not be developed due to lack of information.

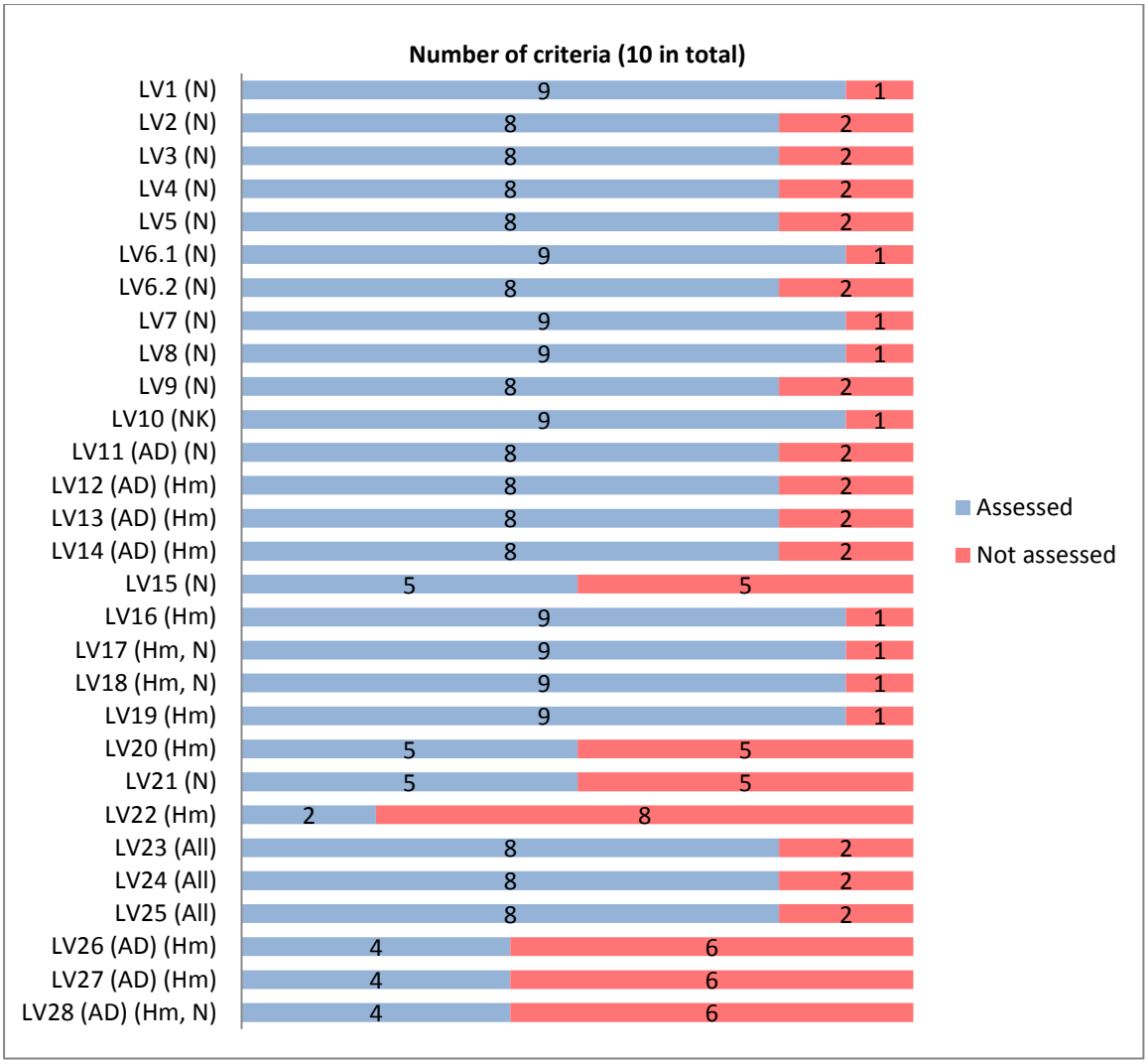

Figure 6.3 Proportion of assessed and not assessed criteria for each measure.

Note: The total number of the criteria is 10 since C2 was not applied in the study. For each measure on the vertical axis its "targeted" water quality problem is shown in brackets, where "N" marks the measures targeting nutrients' pollution, "Hm" marks those targeting hydro-morphological alterations, "All" marks "informational" measures and "NK" "research" measure (where reasons for failing GES of WBs are unknown).

7 Conclusions in light of applicability of the approach and relevant gaps for future work

Experience from the 1st WFD implementation cycle shows that there is need for an approach that would allow:

- considering new potentially effective measures (besides those evaluated with the current approach) and performing the economic evaluation of measures in relation to various pressures and water quality problems;
- more comprehensive assessment and evaluation of measures taking into account, besides their cost-effectiveness, also other relevant socioeconomic and institutional aspects that can facilitate or hinder implementation of the measures.

A general aim of the study was to develop methodological approach that would allow addressing these needs. The study included (i) development of such approach, (ii) collecting available information and applying the approach for assessment and evaluation of measures, (iii) assessment of information provision and gaps and (iv) drawing conclusions and developing recommendations in light of applicability of the proposed approach for the economic evaluation of measures for the next WFD planning cycle.

The proposed approach involves assessment and evaluation of measures from multiple perspectives, which are considered by assessment criteria. The criteria allow capturing the main positive and negative impacts and implementation aspects of measures that are relevant for prioritisation of the measures to substantiate their selection for the programs of measures. The approach is based on multi-criteria analysis framework. The cost-effectiveness of measures is among the considered criteria however not the only one (like in the CEA) for comparison and prioritisation of measures. With this approach measures can be evaluated and even ranked taking into account all relevant criteria (including, for instance, stakeholders' acceptance, funding availability, benefits of implementing a measure). Importance of various criteria was assessed based on an inquiry of specialists from relevant institutions. The results show that all the criteria[47] are seen as important, but they can be grouped in significance groups – criteria of the highest priority (C1, C3, C8, C10 and C11), important criteria (C4, C6, C7 and C9) and criteria with differently viewed importance (C2 and C5).

The study focussed in particular on pressures from agriculture and forestry causing nutrients' pollution to water bodies and hydro-morphological alterations. The approach was applied on measures included in the 1st RBMPs and new measures that were added as part of the study. For reducing nutrients' pollution some measures have been noted in the 1st RBMP without detailed specification. These were further developed and specified. In addition, new measures were included that could potentially be efficient for reducing the pressures. Particularly the hydro-morphological pressures were not sufficiently addressed in the 1st RBMPs, thus majority of the added measures were developed to address these pressures.

In relation to **applicability of the proposed approach** it can be concluded overall that it addresses the identified assessment and evaluation needs.

[47] The criteria include: C1 "Cost-effectiveness of a measure", C2 "Time until the effect after making a measure operational", C3 "Multiple effects of a measure", C4 "Economic costs of a measure", C5 "Administrative costs of implementing a measure", C6 "Indirect costs and wider negative socioeconomic impacts", C7 "Certainty in the effectiveness and costs' assessments of a measure", C8 "Socioeconomic benefits from environmental improvements", C9 "Availability of enforcement scheme(s) for implementing a measure", C10 "Acceptance by stakeholders concerned by implementing a measure", C11 "Certainty in funding availability".

Results from application of the approach demonstrate that there are other potentially (more) cost-effective measures for reducing the nutrients' pollution than those that can be evaluated with the current CEA approach (based on the ECOLAS model). Many of them target the hydro-morphological pressures but can be cost-effective for reducing nutrients' pollution also due to their multiple effects (this aspect is not accounted in the 1st RBMPs when evaluating and selecting measures). As demonstrated by the study, the approach is applicable also to the measures for hydro-morphological pressures.

At the same time the proposed approach based on multi-criteria assessment and evaluation of measures allows considering various relevant impacts and implementation aspects of measures. Results from this study demonstrate that the evaluation outcome in terms of socioeconomic efficiency assessment and ranking of measures changes considerably when additional criteria to the cost-effectiveness of measures are included. Besides, not only the most "priority" criteria, but also other important ones can change the outcome.

Wide range of criteria (11 in total) was applied in the study. But the approach overall is flexible in terms of including those criteria that are seen relevant for decision-making (the evaluation approach as such doesn't change depending on included criteria).

Other important advantage of the proposed approach is that it allows utilizing various types of data and assessments (quantitative and qualitative). This fits better to the information provision in practice, which always faces information gaps.

It is concluded overall that the proposed approach is seen as an applicable tool for the assessment and evaluation of measures to substantiate their selection for the programs of measures. It can provide reliable evaluation results with improved information base and some further refinements in the approach (for instance, refining assessment categories and used assumptions, testing interval values for calculating various summary scores and categories, performing sensitivity analysis of the results).

In order to obtain reliable evaluation results the information base needs to be improved considerably. It is insufficient even for assessing the cost-effectiveness of the measures with sufficient reliability, particularly due to lack of the assessments on costs. Such information gap would need to be filled in even if the "conventional" CEA had to be applied. In addition, **there are important information gaps also for applying other assessment criteria** (e.g. concerning the benefits from environmental improvements and stakeholders' acceptance of the measures). The information and assessments collected and developed as part of this study provides good basis for this further work.

Concerning the **socioeconomic information provision for the assessment of measures, the gap with the highest priority relates to estimates of the costs, starting with the 'financial costs'** of the measures, where quantitative estimates are needed[48]:

- There are several measures in the 1st RBMPs where the costs' estimates should be improved or revised (e.g. where content of a measure was changed but the initial costs' estimates from the ECOLAS model were not adjusted, where no 'financial costs' are assumed in the model however a measure could involve such costs in reality).
- For all measures evaluated for the 1st RBMPs the estimates should be updated, since they were developed in 2007.

[48] Such estimates are needed to develop reliable assessments with the given approach (taking into account the high relevance of this criterion), but also for estimating the costs of programs of measures for the RBMPs.

- There are measures noted in the RBMPs that were not sufficiently specified, consequently also the costs' estimates were not developed for them. This needs to be done for the next cycle.
- The estimates need to be developed for the additional measures proposed by this study that show potential of being cost-effective alternatives for addressing pressures concerning both – nutrients' pollution and hydro-morphological alterations.

Also for the **'economic costs'** quantitative estimates should be developed at least for the measures where they are indicated as relevant. For few measures such estimates were considered in the RBMPs, however they need to be improved by refining assumptions behind them (based on analysis of national data). Concerning the **'administrative costs'**, the information base could be improved for assessing them at least semi-quantitatively.

Improving information base and assessments on direct costs, would allow also better assessment of **indirect costs and wider socioeconomic impacts**. In addition, consultations with experts and stakeholders from the concerned sectors are recommended for improving information base on types and magnitude of such indirect costs/impacts from various measures.

Improving the information base for two other socioeconomic criteria are of similar importance as for the (financial) costs – concerning the benefits from environmental improvements and stakeholders' acceptance of the measures. The developed assessments on the benefits are rough and reflect rather relative magnitude of benefits of the measures against each other than their absolute magnitude, since available information base didn't allow assessing the latter. The magnitude of the benefits depends on location specific conditions, including, natural and use characteristics of WBs. The WB-scale analysis is required to support assessing size of the benefits, when application of the measures would be analysed for concrete areas (WBs). Additional work is needed for quantification (incl., monetary estimation if necessary) of the benefits since the economic valuation studies conducted in Latvia so far don't provide sufficient information base (in particular, concerning the inland waters).

Concerning the criterion on stakeholders' acceptance, there is significant lack of information for many measures, besides not only the new ones added by this study, but also for those included in the 1st RBMPs. The investigation on this issue could include also analysis of factors determining the acceptance of various measures since it would allow targeting efforts for improving it.

An important task for the next RBMPs is to clarify funding sources of the measures. Implementation of majority of the measures (the "technical" measures in particular) will depend largely on availability of public financial support, where the funding sources (and payment schemes) needs to be specified for the next cycle. The analysis showed that clear specifications on funding sources and financial commitments for the next WFD cycle are lacking for all the measures.

All the gaps and recommendations above concern in particular the **measures addressing hydro-morphological pressures.** Since measures for these pressures were not specified sufficiently in the 1st RBMPs, their economic assessment could not be conducted. The available information base is clearly insufficient for the economic evaluation of these measures, even for evaluating their cost-effectiveness.

Information sources used in the study

1. Alterra (2011) *"Recommendations for establishing Action Programmes under Directive 91/676/EEC concerning the protection of waters against pollution caused by nitrates from agricultural sources. Part C: Analysis of the processes in soil that influence nutrient leaching and runoff"*. Wageningen-UR.
2. ARCADIS (2012) *"Economic assessment of policy measures for the implementation of the Marine Strategy Framework Directive. Inventory (Excel database) of measures".* A study for the European Commission.
3. ARCADIS (2012) *"Pilot project '4 Seas' – plastic recycling cycle and marine environmental impact. Case studies on the plastic cycle and its loopholes in the four European regional seas areas"*. Final report of a project for the EC (Project No BE011102328).
4. "Baltic Compass" project (2011) *"Implementation and status of priority measures. Country Report for Latvia".*
5. "Baltic Deal" project (2011) *"Agri-environmental measures in the Baltic Sea Region. Advisory services, legislation & best practices".* Project report.
6. "Baltic Deal" project (2011) *"Study on available agri-environmental measures".* Work Package 4. Project report.
7. "Baltic Deal" project, related documents (in project's website: http://www.balticdeal.eu/measures/): *"Buffer zone farm economy in Denmark", "Buffer zone farm economy in Finland", "Constructed wetlands in Denmark", "Constructed wetland farm economy in Finland", "Wetland farm economy (Wetlands in Sweden)"*, Žūriņš K. (2012) *"Constructing a wetland in Latvia"*.
8. Bottcher D., Izuno F., Hanlon E. (1997) *"Procedural Guide for the Development of Farm Level Best Practice Plans for Phosphorus Control in the Everglades Agricultural Area"*. Institute of Food and Agriculture Services, University of Florida Circular 1177.
9. Clouston R. (1996) *"Best Management Practices to Reduce Diffuse Pollution from Agriculture"*. EA R&D Technical Report P40.
10. Cowx I.G. and Welcomme R.L. edit. (1998) *"Rehabilitation of rivers for fish".* A study undertaken by the European Inland Fisheries Advisory Commission of FAO.
11. CSB statistics about changes in prices and salaries: Table "RCG05. BŪVNIECĪBAS IZMAKSU INDEKSI"; Table "DSG02. STRĀDĀJOŠO MĒNEŠA VIDĒJĀ DARBA SAMAKSA PA DARBĪBAS VEIDIEM".
12. *„Darbības programma "Izaugsme un Nodarbinātība" (ES fondu 2014.-2020. gada plānošanas periodam)".* 2.versija (no 25.07.2013.).
13. Data from a public inquiry on 'supplementary' measures proposed in the (draft) RBMPs (2009). Internal information.
14. Data from an inquiry of members of the RB Consultative Boards on importance of 'supplementary' measures (2010). Internal information.
15. Davies D., Christal A. (1996) *"Buffer strips, a review".* In Diffuse Pollution and Agriculture, 183-192, The Scottish Agricultural College, Aberdeen.
16. De Nocker L. et.al. (2007) *"Costs and Benefits associated with the implementation of the Water Framework Directive, with a special focus on agriculture: Final Report"*. Study for DG Environment.
17. De Sutter R., Van Biervliet K., Van Tomme I., Kirhensteine I. (2005) *"Manual for Cost Effectiveness Analysis (CEA) in the framework of River Basin Management Plans"*. ECOLAS & ELLE.

18. *"Directive 2000/60/EC establishing a framework for Community action in the field of water policy"* (WFD).
19. Ecologic, IWRRM (2003) *"Basic principles for selecting the most cost-effective combinations of measures for inclusion in the program of measures as described in Article 11 of the WFD – Handbook".* Federal Environmental Agency.
20. European Commission (2009) *"Concept Paper on the assessment of WFD River Basin Management Plans".* Version 4. DG ENV.D.1.
21. European Commission (2010) *"Report on project to gather SCG members' views of the experience in the implementation of the economic aspects of the WFD – questionnaire and interview results".*
22. European Commission (2012) "*Commission Staff working document SWD(2012) 379 European Overview". Volume 2. Accompanying the document "Report from the Commission to the European Parliament and the Council on the Implementation of the Water WFD River Basin Management Plans".*
23. European Commission (2012) *"Commission Staff working document SWD(2012) 379. Member state: Latvia". Accompanying the document "Report from the Commission to the European Parliament and the Council on the implementation of the WFD River Basin Management Plans".*
24. European Commission (2012) *"Commission Staff working document SWD(2012) 379. Member state: Estonia". Accompanying the document "Report from the Commission to the European Parliament and the Council on the implementation of the WFD River Basin Management Plans*".
25. European Commission (2012) "*Impact Assessment. Accompanying the document COM SWD(2012)382 A Blueprint to Safeguard Europe's Water Resources". Part 2.*
26. *"European WFD catalogue of measures for agriculture"* (2007, further updates). Initially developed by a project "Catalogue of measures to address diffuse pollution from agriculture" for the EU Strategic Steering Group (SSG) on WFD and Agriculture.
27. *"Fact sheets of agricultural measures for the WFD programs of measures"* (2012) Developed by the project "Comparative study of pressures and measures in the major river basin management plans in the EU". Reference: Frelih-Larsen A., von der Weppen J. (2012) "*Introduction to Factsheets on Environmental Effectiveness of Selected Agricultural Measures".* "Comparative Study of Pressures and Measures in the Major River Basin Management Plans" (Task 3a).
28. Grīnberga L., Jansons V. (2012) *"Mākslīgie mitrāji ūdens piesārņojuma samazināšanai".* LLU.
29. *"Guidance on good practice in the management and creation of small waterbodies in Scotland",* available at http://adlib.everysite.co.uk/adlib/defra/content.aspx?doc=11588&id=11619
30. Hannon G.P., Coffey P. J. (1984) *"Control of silt in peatland".* Proceedings of the 7th International Peat Congress, Dublin, Ireland, 18–23 June 1984. 2: 237–251.
31. Hart K., Baldock D. (2011) *"Greening the CAP. Delivering Environmental Outcomes through Pillar One"*. Institute for European Environmental Policy.
32. Heistad, A., Paruch, A.M., Vråle, L., Adam, K., Jenssen, P.D. (2006) *"A high-performance compact filter system treating domestic wastewater"*. Ecol. Eng. 28 (4), 374–379.
33. Helliwell R., Avery L., Conniff A., McNay D., Gorman J. (2013) *"Reducing pollution from forestry related activities in the Galloway and Eskdalemuir forests: A review of Best Management Practices to reduce diffuse pollution"*. CREW project CD 2012/41.

34. Holsten B., Ochsner S., Schäfer A., Trepel M. (2012) "*Guidelines for the reduction of nutrient discharges from drained agricultural land. Developed for Schleswig-Holstein and transferred to the Baltic Sea region".*
35. Inquiry of specialists (June, 2013) conducted in the frame of this study.
36. Jacobsen B. H. (2007) *"In search of cost-effective measures. Danish report on the use of cost-effectiveness analysis when implementing the EU WFD".* Report No 191. Institute of Food and Resource Economics.
37. Jansons V. (2013) "*Aizsargjoslu pielietošanas lauksaimniecībā pieredzes izpēte. Atskaite par pētījumu projekta izpildi".* LLU Lauku inženieru fakultāte Vides un ūdenssaimniecības katedra.
38. Kampa E., Stein U. (2012) "*Final factsheets on Environmental Effectiveness of Selected Hydromorphological Measures".* 'Comparative Study of Pressures and Measures in the Major River Basin Management Plans' (Task 3b)
39. Knudsen L., Lemming C. (2011) "*Environmental measures in Denmark. Knowledge Centre for Agriculture. Special knowledge of plant production"*. Denmark & Adviser. Knowledge Centre for Agriculture, Denmark.
40. Koskiaho, J., Puustinen, M., Koikkalainen, K., Salo, T. & Piirimäe, K. (2013*) "Modelling, assessments and cost-effectiveness analysis of constructed wetlands and active methods for the treatment of runoff from agricultural areas".* MTT Report 94. 47 p. MTT, Jokioinen. More information at: http://www.balticdeal.eu/measure/constructed-wetlands/#sthash.F9TUZ7Rj.dpuf.
41. Latvian Ministry of Agriculture, data from http://www.zm.gov.lv/?sadala=434.
42. Latvian Rural Advisory and Training Centre, information about agricultural measures from project "Baltic Deal": http://www.llkc.lv/lv/raksts/projekta-baltic-deal-gaita-sagatavotais-agrovides-pasakums-baribas-vielu-bilances, http://www.llkc.lv/lv/raksts/projekta-baltic-deal-gaita-sagatavotais-agrovides-pasakums-piemerotu-meslosanas-lidzeklu.
43. *"Latvijas Lauku attīstības programma 2014.-2020. gadam".* Informatīvā ziņojuma 1.pielikums *"Indikatīvais sabiedriskā finansējuma (ELFLA, LV budžets, pašvaldību līdzfinansējums) sadalījums LAP 2014.2020.gadam"* (variants no 28.06.2013.).
44. *"Latvijas Lauku attīstības programmas 2014.-2020.gadam stratēģiskais ietekmes uz vidi novērtējums*".
45. "Latvijas Valsts Ceļi" (2011) *"Autoceļu būvniecības darba veidu vienības izcenojumi 2011 gadā".* Available http://lvceli.lv/files/Publicejama%20projektu%20dokumentacija/2011_videjas_cenas.pdf.
46. "Latvijas Valsts Ceļi" (2012) *"Autoceļu būvniecības darba veidu vienības izcenojumi 2012 gadā".* Available http://lvceli.lv/files/Publicejama%20projektu%20dokumentacija/2012_gada_videjas_cenas.pdf.
47. "Latvijas Valsts Meži" AS sniegtā tehniskā informācija par sedimentācijas nosēdaku izveidi.
48. LEGMC (2012) *"1st River Basin Management Plans for Daugava, Gauja, Lielupe and Venta RBDs*".
49. LEGMC (2012) *National report "Progress on implementation of the WFD Programmes of measures*".
50. "Meatball" project's website: http://www.ldf.lv/pub/?doc_id=29808.
51. Ministerie van Verkeer en Waterstaat (2005) *"In pursuit of optimal measures packages – Dutch handbook on cost-effectiveness analyses for the EU Water Framework Directive".* Ministerie van Verkeer en Waterstaat. The Netherlands.

52. O'Grady M.F. (2006) *"Channels & Challenges: enhancing Salmonid rivers".* // Irish Freshwater Fisheries Ecology & Management Series, No 4. Central Fisheries Board, Dublin, Ireland.
53. Pakalniete K. (2013) "*Assessing socioeconomic significance of water use for the WFD river basin management planning. Latvian study report".* Gauja/Koiva project.
54. Pakalniete K., Lezdina A., Veidemane K. (2007) "*Assessing environmental costs by applying Contingent Valuation method in the sub-basin of the river Ludza".* Latvian case study. ENCO-BALT project.
55. Paoli G., Mattheiß V., Strosser P. (2012) "*Guidance note on the assessment and reporting of costs and benefits".* Report of a project "Comparative study of pressures and measures in the major river basin management plans in the EU" (Task 4b: Costs & Benefits of WFD implementation).
56. Paoli G., Mattheiß V., Strosser P. (2012) *"Task 4b – Costs & Benefits of WFD implementation: Final report".* Report of a project "Comparative study of pressures and measures in the major river basin management plans in the EU".
57. *„Partnerības līgums ES fondu 2014.-2020. gada plānošanas periodam".* 2.versija (no 25.07.2013.).
58. RPA (2005) *"Development of a Methodology to Determine the Cost-Effectiveness of Measures and Combinations of Measures for the Water Framework Directive (WFD)".* Report for The Collaborative Research Programme on River Basin Management Planning Economics. RPA consortium. England.
59. Salomon E., Sundberg M. (Ed.) (2012) *"Implementation and status of priority measures to reduce nitrogen and phosphorus leakage. Summary of Country Reports".* Baltic Compass Work Package 3.
60. Samuli J. (1996) *"Factors Affecting Sediment Accumulation in Sedimentation Ponds"*. In the Book: Northern Forested Wetlands Ecology and Management.
61. *"Saving the sea from Nutrient Overload by managing Wetlands/grasslands"***.** Project's SNOWBAL website: http://www.snowbal.net/.
62. Schoumans O.F., Chardon W.J. (Ed.) (2011) *"Mitigation options for reducing nutrient emissions from agriculture. A study amongst European member states of Cost action".* Wageningen, Alterra, Alterra-Report 2141.
63. SEPA *"Manual for Best Management Practices (measures) helping to reduce diffuse pollution risk from agricultural activities"* at http://apps.sepa.org.uk/bmp/Default.aspx.
64. Somma F. (ed.) (2013) "*River basin network on Water Framework Directive and Agriculture. Practical experiences and knowledge exchange in support of the WFD implementation (2010-2012)".* The Joint Research Centre of the European Commission.
65. STELLA (2012) "*Costs, benefits and climate proofing of natural water retention measures (NWRM)".* The Directorate-General for the Environment of the EC.
66. Urtāns A. (2010) *"Padomi akmeņu ievietošanai upēs un straujteču veidošanai".* Projekts "Klimata izmaiņas: Ietekme, izmaksas un pielāgošanās Baltijas jūras reģionā.
67. Urtāns A., Urtāne L. (2011) *"Praktiski padomi kā uzlabot ūdensteču funkcionalitāti".* http://www.gwp.org/Global/ToolBox/Case%20Studies/Europe/Latvia.%20Practical%20methods%20to%20manage%20small%20rivers;%20ecosystem%20approaches%20applied%20(%23412).pdf.
68. Urtāne L. (red.) (2012) *"Ūdensceļi un ūdensmalas. Vadlīnijas ūdenstilpju un ūdensteču izmantošanas un apsaimniekošanas plānošanai".* Vidzemes plānošanas reģions.
69. Vagstad N., Stalnacke P., Andersen H.E., Deelstra J., Gustafson A., Ital A., Jansons V. *"Nutrient Losses from Agriculture in the Nordic and Baltic Countries".* TemaNord 2001:591. Nordic Council of Ministers, Copenhagen, ISSN 0908-6692.

70. WATECO (2003) *"Economics and the environment. The implementation Challenge of the Water Framework Directive. Guidance document and accompanying documents to the guidance*".
71. Welch D.J. (1991) *"Riparian forest buffers. Function and Design for Protection and Enhancement of Water Resources".* USDA Forest Service, Northeastern Area – State and Private Forestry, Radnor, PA. NA-R-07-91.
72. Wynne D. (1992) "*Control of peat silt in drainage waters from milled peat production bogs in Bord na Mona".* Proceedings of the 9th International Peat Congress, Uppsala, 2: 55–63.
73. http://www.dvietespaliene.lv/lv/lifeprojekts/publikacijas.

Annex 1: Typology of 'supplementary' measures

The 'supplementary' measures are classified in this study according to categories commonly used internationally. This typology is proposed for future use in Latvia for the WFD needs.

During the work as part of the project it has been compared with the typology used in Estonia for the WFD needs. Also both typologies differ slightly their differences are not significant and they are comparable overall (correspondence between them is shown in the table below). Besides slightly different names of few categories, the only difference is that two categories in Latvia – "Regulatory & administrative measures" and "Economic instruments" are joined in one category in Estonia – "Administrative measures".

Table 1. Categories of measures used in Latvia and their comparison with typology used in Estonia.

<table>
<tr><th>In Latvia</th><th>In Estonia</th></tr>
<tr><td>Regulatory and administrative measures
Include "command-and-control" or regulatory instruments, like norms (e.g. emission limit values/norms), standards, bans, permits, penalties, reporting by operators, requirement on EIA etc.
Also administrative measures, like controlling and enforcement measures/actions, developing/managing/coordinating specific national programs/strategies/plans, regular (state) monitoring etc.</td><td rowspan="2">Administrative measures
Issuing permits (granting/updating/refusing to grant/revocation). Coordination of design conditions and construction permit of land improvement maintenance work.
Environmental monitoring.
Updating the legislation.
Compilation and establishment of guidelines.
Supervision over compliance with the requirements.
Coordination of planning (comprehensive and detailed planning) of public water supply and sewerage development plans, of development plans, of environmental impact assessments and other documents in accordance with the water management plan.
Supervision over the cost of the water service.</td></tr>
<tr><td>Economic instruments
E.g. environmental taxes and subsidies/ compensations etc.</td></tr>
<tr><td colspan="2">Technical measures
Any physical measures having a direct impact on the environment (reducing or mitigating pressures, e.g. WWTP, buffer zones, wetlands, remediation of water ecosystems e.g. re-meandering of a straightened river).</td></tr>
<tr><td>Informational measures
Measures related to information, education, institutional capacity building and awareness rising.
Note! When policies prescribe mandatory public information and consultation (for EIA, issuing permits, national strategies/plans etc.) it is included under the regulatory measures.</td><td>Consulting measures
Consulting of authorities and users of water, incl., consulting and training the public in order to assure the achievement of targets of the water management plan and to assure compliance with the requirements, consulting and training of authorities and advisors, consulting and training of users of water in order to employ appropriate water conservation measures, consulting of consumers and operators and giving advice regarding elimination of health risks in drinking water (bathing water), consulting of water companies (on legislation to implement requirements for wastewater treatment).</td></tr>
<tr><td colspan="2">Research measures
All measures that are related to research, incl. when research/studies/monitoring is proposed for water bodies with unclear reasons for environmental problem, effect of possible measures etc.</td></tr>
</table>

Annex 2: Questionnaire for the inquiry on relevant criteria for the economic evaluation of measures

Estonia Latvia Programme
Linking Estonia and Latvia
European Union
Part-financed by the European Regional Development Fund

Gauja Koiva

Questionnaire of specialists to develop criteria for the socioeconomic evaluation and selection of measures to improve water status

This inquire of specialists is conducted as part of the project "Towards joint management of the transboundary Gauja/Koiva river basin district" (funded by the Estonia-Latvia programme 2007.-2013). The project includes among its tasks harmonisation of approaches and methods for the **socioeconomic analysis of programs of measures to improve water status** in the Gauja/Koiva river basin.

It is required that the programs of measures are "cost-effective" meaning that they are built in a way to reach water quality objectives for the least costs to society. However, the first experience from implementing the programs of measures in the countries shows that many other socioeconomic and institutional aspects are also relevant and can facilitate or hinder the implementation of measures. It also shows that more comprehensive assessment of measures is needed to support policy decision-making and discussions with stakeholders.

Therefore the project aims to develop such an approach where more aspects than only the "cost-effectiveness" of measures could be taken into account when assessing and prioritising the measures. We focus in our work in particular on analysis of measures for reducing the pressures from agriculture and forestry. An opinion of specialists is asked for developing a list of relevant criteria to be taken for the assessment of measures. The opinions are collected by a questionnaire and it is planned that it is completed by specialists from Estonia and Latvia having the following "profiles":

- "Environmental policy specialist" (working on implementation of the WFD and other environmental policies);
- "Environmental specialist" (working with assessments of pressures, state and/or measures for the WFD);
- "Economist of WFD" (working with the economic aspects of the WFD);
- "Concerned actor" (representatives from the agriculture and forestry sector responsible for/involved in implementation of the measures);
- "Relevant stakeholder" (involved in the River Basin Management Planning).

We would like to ask you to provide your response on the questionnaire included further.

1) Your country:

☐ Estonia ☐ Latvia

2) Your "profile" (only one – the main):

☐ "Environmental policy specialist" ☐ "Environmental specialist"

☐ "Economist of WFD" ☐ "Relevant stakeholder"

☐ "Concerned actor" (representative from agriculture or forestry sector)

3) Please assess each criterion for the socioeconomic evaluation and selection of measures to improve water status in the table below according to scale from 1 "low relevance" to 5 "high relevance". If you think that the criterion is not relevant (should not be used), please assign 0-value to it.

4) Please tick in the last column of table (☒) **five the most important to your opinion criteria from the listed.**

NOTE! Explanations of the criteria are provided at the end of the questionnaire.

Proposed criteria for the socioeconomic evaluation and selection of measures to improve water status	**3) Weight [from 0 to 5]**	**4) five the most important criteria**
[1.] Cost-effectiveness of a measure		☐
[2.] Time until the effect after making a measure operational		☐
[3.] Multiple effects of a measure (effect on various water quality elements/pressures)		☐
[4.] Economic costs of a measure		☐
[5.] Administrative costs of implementing a measures		☐
[6.] Indirect costs and wider negative socioeconomic impacts		☐
[7.] Certainty of the effectiveness and costs' assessments of a measure		☐
[8.] Socioeconomic benefits from environmental improvements (from water-related and positive environment-related side effects)		☐
[9.] Availability of enforcement (incl. controlling) scheme(s) for implementing a measure		☐
[10.] Acceptance by stakeholders concerned by implementing a measure		☐
[11.] Certainty in funding availability		☐
Other relevant criterion not covered by the list above. Please specify _____		☐

If you have any comments concerning the listed criteria (e.g. their content, formulation), please, include them here:

_____

_____

We would appreciate sending your response to Kristine Pakalniete (kristinepa@apollo.lv)!

Explanations of the criteria:

[1.] Cost-effectiveness (CE) of a measure – commonly calculated as annual costs of a measure divided by its effect (e.g. EUR / 1 kg of reduced N). It allows comparing various measures and selecting those that ensures the "least cost way" to specified environmental objective. The CE is estimated here taking into account only effect on the "targeted" water quality parameter/pressure (e.g. nutrients) and financial costs of a measure (i.e. investment, operation and maintenance costs), without taking into account other effects and types of costs of a measure since these impacts are considered in other criteria.

[2.] Time until the effect after making a measure operational – describes time period after implementing a measure within which the environmental improvement takes place.

[3.] Multiple effects of a measure – effects on various WFD water quality elements (e.g. physicochemical and/or hydro-morphological quality elements). They are accounted if a measure improves state in relation to more than one water quality element.

[4.] Economic costs of a measure – besides the direct financial costs, measures may create other direct costs to those who implement them, for instance, as foregone income due to yield loss when converting arable land to other land use type. It should be note that some measures may create also economic gains (e.g. saved costs on fertilisers thanks to more efficient fertilisation planning and application). Both are considered under this criterion.

[5.] Administrative costs of implementing a measure – costs of administrations for monitoring, control, enforcement etc.

[6.] Indirect costs and wider negative socioeconomic impacts can be related to negative "secondary"/wider impacts on the sectors who implement the measures and the related sectors, distributional impacts in terms of geographical and social distribution of the costs (e.g. impact on vulnerable groups of the society).

[7.] Certainty of the effectiveness and costs' assessments of a measure is low in cases when the assessments are very rough/uncertain and is high in cases when there is good information & knowledge about what the actual costs and effects of measures are. This is relevant since these effectiveness and costs' estimates are used for prioritising measures and deciding on which measures should be implemented.

[8.] Socioeconomic benefits from environmental improvements (from water-related and environment-related side effects) – benefits to society and economy from improved water and environmental quality achieved by implementing a measure. "Environment-related side effects" create benefits if a measure gives also improvements besides those directly related to the water environment, e.g. has a positive impact also on biodiversity, soil quality, air emissions etc.

[9.] Availability of enforcement (incl. controlling) scheme(s) for implementing a measure – the enforcement requires various instruments and institutional structures to make a measure "operational". Including, instruments for implementation of a measure (e.g. setting a measure as "cross-compliance" requirement for the CAP, setting a compensation payment covering the costs of a measure), institutions and schemes for administration, control, penalties.

[10.] Acceptance by stakeholders concerned by implementing a measure – the level of acceptance is measured from "low" to "high". The acceptance may be different for various measures, for instance, due to lack of knowledge about effects and/or costs of a measure, distrust to the positive environmental effect, different socioeconomic interests of various stakeholders etc. Practice shows that the acceptance is an important precondition for making a measure operational.

[11.] Certainty in funding availability is low if possible funding is unclear, and high if a funding instrument/source is known and there is confidence that the funding will be allocated from there.

Annex 3: Description of "technical" measures included in the study

Arranging environmentally safe manure storage facilities (LV1)

The description of the measure is kept like it was in the 1st RBMPs (2010).

The specification was complemented by the project taking into account requirements of the national regulations when this measures is required as mandatory – in the NVZ according to the Nitrate Directive and in whole Latvia according to the national regulations[49] and CAP (as "cross-compliance" requirement for receiving direct payments). However, on-going negotiations on future CAP might impact the mandatory requirements of the measure for future period. This should be checked for the next RBMPs in order to harmonise the measure of both – as the mandatory measure according to other policies and 'supplementary' measure of the WFD.

According to the 1st RBMPs the measure includes two technical solutions – construction of manure storage facility and/or appropriate manure storage on field. These solutions have different costs and effect. Their actual implementation practice should be investigated in order to adapt the costs and effect estimates of the measure appropriately.

Name of the measure: Arranging environmentally safe manure storage facilities.

Description of the measure (according to the programs of measures of the 1st RBMPs):[50]

In farms with more than 5 animal units (outside the NVZ, since it is required as a "basic measure" for such farms in the NVZ), environmentally safe manure storage facilities are arranged. The measure includes both the construction of manure storage facility and/or appropriate manure storage on field. Implementation of the measures reduces N and P load.

Specification of the measure:

The measure aims to reduce nutrient leaching from manure storage to nearby water bodies. Environmentally safe manure storage facilities mean that:

- Capacity of manure storage must enable accumulation of the collected manure for solid manure – at least 6 months, for liquid manure and manure water reservoirs – for 7 months. If liquid manure or solid manure storage capacity is too small to meet the requirements, a farmer must contract other farm or other entity with adequate capacity or deliver manure for processing outside farm.
- Manure collection and disposal systems in farms must be constructed of waterproof material that is resistant to the farm activities and possible machinery caused damages.

Information sources used for the specification of the measure:

- Programs of measures of the 1st RBMPs (2010).
- Progress reports on implementation of the WFD Programmes of measures in Latvia (2012).
- Baltic Compass (2011) *Implementation and status of priority measures. Country Report for Latvia.*

[49] Regulations of the Cabinet of Ministers N° 628 about environmental requirements for animal housings prescribes manure storage facilities for all A category farms and C category farms (categories for polluting activities), if they hold more than 10 animal units in whole Latvia and more than 5 animal units in NVZ.

[50] In the 1st RBMPs, the measure was not proposed for the Gauja RBD, only for selected WBs of Daugava RBD.

Construction of biological WWTP in dairies (LV2)

The description and specification of the measure is kept like it was in the 1st RBMPs (2010).

However it should be noted that specification of the measure includes recommendations on introducing in the farms water saving system by planning water use cycle and water re-use. The regulations for milk chain [in Latvian – *piena aprites noteikumi*] specify that "technical water" may be used only for steam production, fire fighting equipment and cooling facilities, but technical rooms, facilities and equipment must be washed with water corresponding to the drinking water quality. It should be reconsidered if this limits application of the given recommendation.

Name of the measure: Construction of biological WWTP in dairies.

Description of the measure (according to the programs of measures of the 1st RBMPs):[51]

Construction of biological WWTP in dairies in all farms with more than 230 dairy cows.

Specification of the measure:

Construction of individual biological WWTP in dairies in farms with more than 230 dairy cows (corresponds to 5 PE) would allow treatment of their WW (e.g. from washing of milk-churns/systems) and would reduce phosphorus load to the environment. It should also be considered to introduce in these farms water saving system by planning the water use cycle in a farm and water re-use in a dairy. *[The water re-use should be re-considered as noted in the box above.]*

Information sources used for the specification of the measure:

- Programs of measures of the 1st RBMPs (2010).
- Progress reports on implementation of the WFD Programmes of measures in Latvia (2012).

Crop fertilisation planning (LV3)

The description of the measure is kept like it was in the 1st RBMPs (2010).

The specification is developed taking into account requirements of the national regulations when this measures is required as mandatory – in the NVZ according to the Nitrate Directive and in whole Latvia according to the CAP (as "cross-compliance" requirement for receiving direct payments).

Name of the measure: Crop fertilisation planning.

Description of the measure (according to the programs of measures of the 1st RBMPs):[52]

In farms whose land borders with watercourse or water body and who spread fertilisers on the agricultural land of an area more than 20 ha, as well as growing vegetables, fruit trees and fruit brushes in an area more than 3 ha, crop fertilisation is planned.

Specification of the measure:

Crop fertilisation planning, incl. developing of fertilisation plans, means that nutrient balance is determined in the soil and according to it (a lack or surplus of nutrients) decisions are made on need for fertilizing and appropriate crop cultivation.

[51] In the 1st RBMP, the measure is not proposed for the Gauja RBD, only in one WB of the Daugava RBD.

[52] In the 1st RBMP, the measure is not proposed for the Gauja RBD, but proposed for all other RBD.

Plans are made based on soil agrochemical mapping data, which are not older than 5 years. Rural consultation services can help for developing the plans. The plans are developed and submitted to State Plant Protection Service yearly until May 15. If developed fertilizer plan of the cultivated plants specifies or faces significant changes (for example, the planned ha of winter crops change) corrected fertilizer plans are submitted no later than within 10 days after the planned change. Fertiliser plans are stored at least for 3 years.

Information sources used for the specification of the measure:

- Programs of measures of the 1st RBMPs (2010).
- Progress reports on implementation of the WFD Programmes of measures in Latvia (2012).
- Baltic Compass (2011) *Implementation and status of priority measures. Country Report for Latvia.*

Winter green areas and stubble fields (LV4)

The description of the measure is kept like it was in the 1st RBMPs (2010).

The specification is complemented by the project based on review of literature.

For the next period, it is suggested to discuss with agricultural and environmental specialists if the measure shouldn't be targeted to fields bordering water course/body (not all farms whose land borders with water course/body).

Name of the measure: Winter green areas and stubble fields.

Description of the measure (according to the program of measures of the 1st RBMP for Gauja RBD):[53]

In order to reduce nutrient run-off from agricultural land, in farms whose land borders with water course or water body, winter green areas and stubble fields shall be maintained in winter.

Specification of the measure:

Winter green areas' or stubble fields' maintenance means that field is not ploughed after harvest. The measure reduces soil erosion and leaching of nutrients to waters (phosphorus in particular) during the (winter) period without vegetation. Plant cover in winter can consist of growing plants like green fallows, perennial horticultural plants, catch crops, winter cereals and oil seed plants, or stubble of crops.

Information sources used for the specification of the measure:

- Programs of measures of the 1st RBMPs (2010).
- Progress reports on implementation of the WFD Programmes of measures in Latvia (2012).
- Putting best agricultural practices into work. Project's Baltic Deal website: http://www.balticdeal.eu/measures/.

[53] In the 1st RBMP, the measure is proposed for two WBs of the Gauja RBD – G220 Abuls and E225 Burtnieku Lake.

Green manure (LV5)

The description of the measure is kept like it was in the 1st RBMPs (2010).

The specification is complemented by the project based on review of literature.

Name of the measure: Green manure.

Description of the measure (according to the program of measures of the 1st RBMP for Gauja RBD):[54]

In order to reduce nutrient run-off from agricultural land, for fertilization of fields along drainage ditches only green manure shall be used.

Specification of the measure:

The measure means that no fertilizers or manure are used for fertilization of the soil but after harvest residues of plants or specially cultivated plants are used instead. One-year or perennial plants may be used. For instance, winter rye (in particular, together with vetch) can be used as the green manure, if crushed by mill at time of flowering and ploughed into soil. Commonly used green manure is clover and vetch together with different kind of grass. Green part of plants is mowed down 1-2 times and cultivated into soil.

If residues of plants decompose relatively quickly after cultivation into soil, risk of nitrogen leaching increases. In order to reduce the risk, ploughing of the green manure should be conducted in late autumn or the next spring. The leaching risk can be minimised also if sowing winter crops after ploughing of the green manure.

The green manure stores nitrogen in the soil, prevents (wind and water) erosion, optimises precipitation, improves soil structure, biological activity and pH level.

Information sources used for the specification of the measure:

- Programs of measures of the 1st RBMPs (2010).
- Progress reports on implementation of the WFD Programmes of measures in Latvia (2012).
- Latvian Rural Advisory and Training Centre (project Baltic Deal), http://www.llkc.lv/lv/raksts/projekta-baltic-deal-gaita-sagatavotais-agrovides-pasakums-piemerotu-meslosanas-lidzeklu

Buffer zones in agricultural land (according to the 1st RBMPs)

Name, description and specification of the measure are changed by the project based on literature (with recommendations and information on practice in Latvia) and expert knowledge.

At first, the description of the measure according to the 1st RBMPs is provided. The initial version of the description is included here to ease indication of the proposed changes. The proposal with changes follows then.

Description of the measure according to the 1st RBMP for Gauja RBD

Name of the measure: Buffer zones in agricultural land.

Description of the measure:

In order to reduce nutrient run-off from agricultural land, in farms whose land borders with water course or water body:

[54] In the 1st RBMP, the measure is proposed for one WB of the Gauja RBD – G220 Abuls.

1. buffer zones of 5 m on banks of all water courses (excluding those mentioned in point 2 below) and on banks of water bodies, the area of which is less than 50 ha, should be maintained if possible;
2. buffer zones of 10 m on the banks of the Gauja River, its first order tributaries and water bodies, the area of which is more than 50 ha, shall be maintained.

It needs to be stressed that the listed above are general terms of application of the measure. According to these general terms the measure is proposed (based on the cost-effectiveness analysis) only in a few selected WBs of the Gauja RBD failing quality targets.[55] The general terms are revised by the project but not the proposed application in terms of WBs.

Specification of the measure:

Riparian buffer zones are uncultivated areas with perennial grassland located on farmland arable land next to watercourse, water body and drainage ditches.

The buffer zones need to be managed by mowing – at least once a year in the period from July 10 to September 10.

The buffer zones shall be managed in accordance with regulatory requirements on restrictions of economic activities in Protection zones adjacent to (i) water bodies and watercourses and (ii) land amelioration structures and equipment (i.e. "*Protection Zone Law*"), e.g. to use fertiliser material and chemical plant protection products.

Issues that called for clarification

It is unclear from the 1st RBMPs if the measure should be applied to drainage ditches also.

In the specification of the measure included in the 1st RBMPs the drainage ditches are mentioned. However the special annex on programs of measures (where also the terms of application are specified) they are proposed only on banks of water courses and bodies.

Specification of the measure in the 1st RBMPs have arisen questions from stakeholders also. Issues that should be made clear for the next RBMPs:

- along what types of water bodies they should be applied – including drainage ditches or not (are they meant as riparian or field buffer zones);
- asked and prohibited actions in these zones besides those that are required already for the Environmental Protection Zones according to the Law of Protection Zones (mandatory in whole Latvia).

In order to prevent confusions and to improve the potential efficiency and applicability of the measure, it is proposed to distinguish two sub-measures (see the following chapters):

1. Agricultural land buffer zones for water courses and bodies (LV6.1);
2. Agricultural land buffer zones for drainage ditches (LV6.2).

[55] 10 m buffer zones in G220 Abuls (on 25 km^2 area) and E225 Burtnieku Lake (on 25 km^2 area), as well as for selected lake WBs with unknown reasons of being "at risk" if after research the measure would be considered as appropriate (E197 Sārumezers, E199 Katvaru Lake, E202 Vaidavas Lake, E215 Aijažu Lake, E217 Riebezers, E219 Lādes Lake, E222 Dūņezers).

Agricultural land buffer zones for water courses and bodies (LV6.1)

Name of the measure: Agricultural land buffer zones for water courses and water bodies.

Description of the measure:

In order to reduce nutrient run-off from agricultural activities, in intensively used agricultural lands (see the Text box 1) along the water course or water body:

1. buffer zones of 3 m on banks of all water courses and water bodies must be maintained;
2. buffer zones of 5 m on banks of all water courses (excluding those mentioned in point 3 below) and on banks of water bodies, the area of which is less than 50 ha, are maintained if possible;
3. buffer zones of 10 m on the banks of the Gauja River, its first order tributaries and water bodies, the area of which is more than 50 ha, are maintained if possible.

Text box 1:

Intensively used agricultural land:

Is arable land (CORINE LandCover code 21), permanent crops (CORINE LandCover code 22) including areas with cultivated grassland.

Specification of the measure

The main objective of proposed measure is nutrient control and management and sediment control and erosion management achieved by limitation of intensity of agricultural activities within riparian zone of water courses/water bodies.

The effect of this measure is increased nutrient accumulation capacity within riparian zone of water courses/water bodies and reduction of nutrient load.

The measure is referred to areas between river (including regulated river having the status of *State water runoff*) or lake and **intensively used agricultural lands** (refer to the Text box 1), in which additionally to **requirements set by existing legislation** (refer to the Text box 2) the 3 meter wide (proposed as mandatory) and 5 or 10 meter wide (proposed as recommended, the width depends on size of a WB) **not intensively used zones with maintained natural or sown perennial grasses are left**.

Text box 2:

Requirements set by existing legislation:

Prohibition to apply fertilizers in 10 m wide zone (*The Law on Protected Belts, the point 1.5 of the paragraph 37*) and 50 meter wide zone in cases when the slope towards the water body or water course is larger than 10 degrees (*Regulations of the Cabinet of Ministers N^{o} 33 (from 11.01.2011), Paragraph 3.1.3*).

By nature the proposed buffer zone is 'riparian buffer zone' and its function is limitation of nutrients runoff to the surface water body. The establishment of buffer zone is guarantee that requirements set by existing legislation (refer to the Text box 2) are effectively introduced in practice.

The buffer zone must be cut at least once between 10th of July and 10th of September, and must be managed taking into account the requirements set by existing legislation.

Information sources used for the specification of the measure:

- Programs of measures of the 1st RBMPs (2010).
- Progress reports on implementation of the WFD Programmes of measures in Latvia (2012).
- Putting best agricultural practices into work. Project's Baltic Deal website: http://www.balticdeal.eu/measures/.
- Baltic Compass (2011) *Implementation and status of priority measures. Country Report for Latvia.*

- Jansons V. (2013) *Aizsargjoslu pielietošanas lauksaimniecībā pieredzes izpēte*. Atskaite par pētījumu projekta izpildi. LLU Lauku inženieru fakultāte Vides un ūdenssaimniecības katedra.
- Urtāne L. (red.) (2012) *Ūdensceļi un ūdensmalas. Vadlīnijas ūdenstilpju un ūdensteču izmantošanas un apsaimniekošanas plānošanai.* Vidzemes plānošanas reģions.
- Urtāns A., Urtāne L. (2011) *Praktiski padomi kā uzlabot ūdensteču funkcionalitāti.* http://www.gwp.org/Global/ToolBox/Case%20Studies/Europe/Latvia.%20Practical%20methods%20to%20manage%20small%20rivers;%20ecosystem%20approaches%20applied%20(%23412).pdf
- Vagstad N., Stalnacke P., Andersen H.E., Deelstra J., Gustafson A., Ital A., Jansons V. *Nutrient Losses from Agriculture in the Nordic and Baltic Countries.* TemaNord 2001:591. Nordic Council of Ministers, Copenhagen, ISSN 0908-6692.
- Hart K. and Baldock D. (2011) *Greening the CAP. Delivering Environmental Outcomes through Pillar One.* Institute for European Environmental Policy.

Agricultural land buffer zones for drainage systems (LV6.2)

Name of the measure: Agricultural land buffer zones for drainage systems.

Description of the measure:

In order to reduce nutrient run-off from agricultural activities, in intensively used agricultural lands (see the Text box 3) buffer zones of 2 m on banks of drainage ditches, excluding contour ditches (in Latvian – *kontūrgrāvis*) are maintained.

Specification of the measure:

The main objective of the proposed measure is nutrient control and management and sediment control and erosion management achieved by limitation of intensity of agricultural activities within field buffer zones.

The main effect of this measure is increased nutrient accumulation capacity within riparian zone of water courses/water bodies and reduction of nutrient load.

Text box 3:

Intensively used agricultural land:

Is arable land (CORINE LandCover code 21), permanent crops (CORINE LandCover code 22) and complex cultivation patterns (CORINE LandCover code 242).

The measure is referred to areas between open melioration system and its elements and **intensively used agricultural lands** (refer to the Text box 3) in which 2 meters **wide zones with maintained grasses are left, with exception of areas along natural grasslands.** In the given context the term – *elements of open melioration system* includes[56] surface water recipients, receiving ditches and water drains (in Latvian - *virszemes ūdens uztvērēji, novadgrāvji, ūdensnotekas*) with exception of contour ditches (in Latvian – *kontūrgrāvis*). The given measure is not referred to natural or regulated water courses, to which the measure *"Agricultural land buffer zones for water courses and bodies"* is applied.

By nature the proposed buffer zone is uncultivated 'field buffer zone' whose function is to decrease nutrients' runoff and reduce sedimentation caused by the water induced soil erosion.

Field buffer zone **must be cut at least once** between the 10th of July and the 10th of September and must be managed taking into account the requirements set by existing legislation.

Information sources used for the specification of the measure:

- Programs of measures of the 1st RBMPs (2010).

[56] The terms according to the Regulations of the Cabinet of Ministers N° 631 (23.08.2005).

- Progress reports on implementation of the WFD Programmes of measures in Latvia (2012).
- Putting best agricultural practices into work. Project's Baltic Deal website: http://www.balticdeal.eu/measures/.
- Baltic Compass (2011) *Implementation and status of priority measures. Country Report for Latvia.*
- Jansons V. (2013) *Aizsargjoslu pielietošanas lauksaimniecībā pieredzes izpēte*. Atskaite par pētījumu projekta izpildi. LLU Lauku inženieru fakultāte Vides un ūdenssaimniecības katedra.
- Urtāne L. (red.) (2012) *Ūdensceļi un ūdensmalas. Vadlīnijas ūdenstilpju un ūdensteču izmantošanas un apsaimniekošanas plānošanai.* Vidzemes plānošanas reģions.
- Urtāns A., Urtāne L. (2011) *Praktiski padomi kā uzlabot ūdensteču funkcionalitāti.* http://www.gwp.org/Global/ToolBox/Case%20Studies/Europe/Latvia.%20Practical%20methods%20to%20manage%20small%20rivers;%20ecosystem%20approaches%20applied%20(%23412).pdf
- Vagstad N., Stalnacke P., Andersen H.E., Deelstra J., Gustafson A., Ital A., Jansons V. *Nutrient Losses from Agriculture in the Nordic and Baltic Countries.* TemaNord 2001:591. Nordic Council of Ministers, Copenhagen, ISSN 0908-6692.
- Hart K. and Baldock D. (2011) *Greening the CAP. Delivering Environmental Outcomes through Pillar One.* Institute for European Environmental Policy.

Good felling practice (LV7)

The description and specification of the measure is overall kept like it was in the 1st RBMPs (2010).

However consultations with specialists indicate that **the description and specification should be clarified and/or corrected for the next RBMPs, including that it wouldn't overlap with the measure *"Forest buffer zones"* (see the next measure LV8).**

Name of the measure: Good felling practice.

Description of the measure (according to the program of measures of the 1st RBMP for Gauja RBD):[57]

In order to reduce nutrient run-off from forestry land (primary) and to minimise sedimentation (secondary), in lands bordering water course or water body, to comply with requirements of good forest management practice - the use of special equipment (for cutting, logging, etc.) in order to avoid too much soil compaction, and also to leave the greatest possible % of non-felled trees in the felling area.

Specification of the measure:

Good felling practice includes leaving the greatest possible percentage of non-felled trees in the felling area and using special equipment for forestry activities.

Information sources used for the specification of the measure:

- Programs of measures of the 1st RBMPs (2010).

[57] In the 1st RBMP, the measure is proposed for 3 WBs of the Gauja RBD – G209 Gauja River (in area of 2 km^2), E217 Riebezers Lake (in area of 2 km^2), E225 Burtnieku Lake (in area of 10 km^2).

- Progress reports on implementation of the WFD Programmes of measures in Latvia (2012).

Forest buffer zones (LV8)

The description of the measure is overall kept like it was in the 1st RBMPs (refer to the Text box 4). The specification has been complemented by the project based on expert knowledge by clarifying the limitations/requirements for forestry activities in the buffer zone.

Name of the measure: Forest buffer zones.

Description of the measure:[58]

In order to reduce nutrient run-off from forestry and to minimise sedimentation, buffer zones of 10 m on banks of all water courses and water bodies are maintained.

Specification of the measure:

The main objective of the measure is nutrient management and sediment control and erosion management achieved by limitation of forestry activities intensity within riparian zone of water courses/water bodies.

The effect of the measure is increased nutrient accumulation capacity within riparian zone of water courses/water bodies and reduction of nutrients' pollution load thereby.

The measure *"Forest land buffer zones along watercourses and water bodies"*, is referred to 10 meter wide zone along the river (including regulated river which has status of State water runoff) or lake, in which **additionally to requirements set by existing legislation** (refer to the Text box 5) e.g. concerning clear cutting (latv. – kailcirte) and final cutting (latv. – galvenā cirte), the forestry activities are limited by **leaving larger tree density when conducting thinning (latv. – kopšanas cirte). The exception is forest stands with spruces of one age.**

Text box 4:

Specification of the measure according to the 1st RBMPs:

In forestry lands (clear cuts and drained areas) bordering watercourse or water body, to leave as much as possible trees and bushes (e.g. osier) in the buffer zone of 10 m on the banks of watercourses and water bodies when doing forest logging.

Should be noted that not everywhere this measure is applicable – if according to watercourse's/ water body's ecological requirements such measure is not supported (e.g. due to a need for sunlight).

Text box 5:

Requirements set by existing legislation: Protection Zone Law

In the 50 m wide zones* it is prohibited to perform clear-cut, except the cutting trees for exceptional cases (specified by the Law).

In the 10 m wide zones* it is prohibited to perform main felling, except the cutting trees for exceptional cases (specified by the Law) and to perform transformation of forest lands if it is not related to exceptional cases.

* Width of protection zones depends on type and size of water bodies.

Information sources used for the specification of the measure:

- Programs of measures of the 1st RBMPs (2010).
- Progress reports on implementation of the WFD Programmes of measures in Latvia (2012).
- Urtāne L. (red.) (2012) *Ūdensceļi un ūdensmalas. Vadlīnijas ūdenstilpju un ūdensteču izmantošanas un apsaimniekošanas plānošanai.* Vidzemes plānošanas reģions.
- Urtāns A., Urtāne L. (2011) *Praktiski padomi kā uzlabot ūdensteču funkcionalitāti.* http://www.gwp.org/Global/ToolBox/Case%20Studies/Europe/Latvia.%20Practical%20me

[58] In the 1st RBMP, the measure is proposed for 3 WBs of the Gauja RBD – G209 Gauja River (in area of 2 km^2), E217 Riebezers Lake (in area of 2 km^2), E225 Burtnieku Lake (in area of 10 km^2).

thods%20to%20manage%20small%20rivers;%20ecosystem%20approaches%20applied%20(%23412).pdf

Nutrients' retention ponds in agricultural drainage systems (LV11)

The measure is proposed in the 1st RBMPs in a set of measures for reducing nutrient's run-off to lakes, thus it is renamed according to the idea (to reduce nutrients' pollution load) – "nutrients' retention ponds" (in Latvian *biogēnu izgulsnēšanas dīķi*) (*"sedimentation ponds or wetlands"* previously – see the Text box 6).

The specification of the measure is not provided in the RBMPs, since it was thought to be specified after a research measure (included in the 1st program of measures – *"Research and proposals for lakes with unknown reason "at risk"* (LV10)[59]). The specification of the measure has been prepared by the project.

The measure is proposed as possible option for other water bodies also (not only for the specified lake WBs) – in cases where the economic analysis would indicate it as potentially cost-effective option for reducing nutrients' pollution load to WBs failing GES (due to this pressure).

It is also proposed to be considered as part of "environment friendly management" of agricultural drainage systems – see the measure LV21. But the terms of application differ for these two cases (the measure here and LV21).

Name of the measure: Nutrients' retention ponds in agricultural drainage systems.

Description of the measure:

In order to reduce nutrient load from agricultural activities, the nutrients' retention ponds are constructed on drainage ditches before its entering into surface water body where high nutrient loads are estimated.

Specification of the measure:

The main objective of the measure is nutrient control achieved by installation of hydro-technical structures (the nutrients' retention ponds). The effect of this measure is reduction of nutrient load to surface water bodies.

Text box 6:

Description of the measure according to the 1st RBMPs:

Name of the measure: Sedimentation ponds.

Description of the measure:

In drainage ditches, where it is considered to be necessary (after research), sedimentation ponds or wetlands shall be constructed near the lakes.

The nutrients' retention ponds must be located before collected drainage water is entering into surface water body[60] and they are maintained permanently.

The nutrients' retention ponds are proposed here to be constructed on operating drainage systems. Their installation during the reconstruction/renovation of drainage systems is considered as a separate measure under the "environment friendly management of drainage systems" (see the measure LV21) with different purpose and terms of application.

[59] Proposed for the following 8 lake WB: E197 Sārumezers, E199 Katvaru Lake, E202 Vaidavas Lake, E215 Aijažu Lake, E217 Riebezers, E219 Lādes Lake, E222 Dūņezers and E225 Burtnieku Lake.

[60] The location of nutrients' retention pond is crucial issue with respect both to nutrient reduction effects and cost-efficiency. According to modelling carried out by Finnish experts to reduce agricultural nutrients' pollution loads it is highly recommended to locate nutrients' retention pond: (i) near to the source within areas of animal production (cattle, pig, poultry) or (ii) before collected drainage water is entering into surface water from areas of crop (e.g. cereals, fodder) production.

Retention ponds are constructed wetlands (CW) with surface flow (in Latvian – *Virszemes noteces mākslīgais mitrājs*) designed primarily to reduce nutrients. The feature of the given system is its capability to store water and to transform dissolute nutrients into green plant mass. Contrary to horizontal subsurface flow CW, the surface flow CW allows water to flow above ground, exposed to the atmosphere and direct sunlight. Therefore the reduction of nutrient load is conducted in layer of open water and not in soil filter as it is in case of sub-surface flow CW.

The installation of hydro-isolation to separate drainage water from groundwater is not needed if CW is used to reduce nutrient run-off from agricultural areas. The recommended depth of nutrients' retention pond is 0.25-2 m. Flow into the CW is achieved by using the natural gradient. The shallow part of pond is planted with native vegetation (e.g. reeds and/or rushes). The optional water retention time in is >3 days. To obtain such condition the bottom of the retention pond must be constructed in a way to keep the water within the nutrients' retention pond and to avoid direct water flow through it. Since the water flows through the system at low velocities, particulates and suspended solids will settle in the CW and the wetland vegetation can reduce nutrient load.

The estimation of surface area of CW is based on results of hydrological calculation and evaluation of pollution loads. According to literature the good treatment efficiency is achieved if surface area of CW is approximately 0.1-10 % from the catchment area.

The accumulated sediments in the sedimentation basin need to be removed on regular basis for maintenance. Regular maintenance should ensure that water is not short-circuiting, or backing up because of sediments, or beaver dams blocking the wetland outlet. Vegetation also may have to be cut back or thinned out periodically. The sediment will have to be removed in average every five years depending on the amount of accumulated products.

It should be noted that there are recent examples of implementing various technical solutions for sediment and nutrient flows reduction in agricultural drainage ditches in Latvia. More information about these experiences can be obtained from projects Baltic Deal, Meatball, SNOWBAL. For instance:

Project Baltic Deal: http://www.llkc.lv/lv/nozare/projekti-baltic-deal

Latvian Fund for Nature, project MEATBALL: http://www.ldf.lv/pub/?doc_id=29808.

These experiences should be looked closer to complement knowledge and information base for the proposed measure (incl. on effect, costs, technical specification of measure).

Information sources used for the specification of the measure:

- Holsten B., Ochsner S., Schäfer A., Trepel M. (2012) *Guidelines for the reduction of nutrient discharges from drained agricultural land*. Developed for Schleswig-Holstein and transferred to the Baltic Sea region.
- Baltic Compass (2011) *Implementation and status of priority measures. Country Report for Latvia.*
- Koskiaho, J., Puustinen, M., Koikkalainen, K., Salo, T. & Piirimäe, K. (2013) *Modeling, assessments and cost-effectiveness analysis of constructed wetlands and active methods for the treatment of runoff from agricultural areas*. MTT Report 94. 47 p. MTT, Jokioinen. See more at: http://www.balticdeal.eu/measure/constructed-wetlands/#sthash.F9TUZ7Rj.dpuf.
- Grīnberga L., Jansons V. (2012) *Mākslīgie mitrāji ūdens piesārņojuma samazināšanai.* LLU.
- Heistad, A., Paruch, A.M., Vråle, L., Adam, K., Jenssen, P.D. (2006) *A high-performance compact filter system treating domestic wastewater.* Ecol. Eng. 28 (4), 374–379.

- Urtāne L. (red.) (2012) *Ūdensceļi un ūdensmalas. Vadlīnijas ūdenstilpju un ūdensteču izmantošanas un apsaimniekošanas plānošanai.* Vidzemes plānošanas reģions.
- Guidance on good practice in the management and creation of small waterbodies in Scotland. http://adlib.everysite.co.uk/adlib/defra/content.aspx?doc=11588&id=11619.

Sedimentation ponds to reduce impact of soil erosion from forestry activities (LV12)

This measure with the purpose and application as described here was not proposed in the 1st RBMPs. The sedimentation ponds were considered in the RBMPs under the measure for reducing hydro-morphological pressures named as *„Environment friendly management of drainage systems"*, which prescribes to apply established conditions (specified by „technical provisions" – see the measure LV17) of environment friendly hydro-technical construction when maintaining, constructing, renovating or reconstructing drainage systems. The sedimentation ponds as part of the "environment friendly management" are considered also further (see the measure LV14). However they differ with the proposed purpose and terms of application.

Specification of the measure was not provided in the RBMPs, thus it was developed by the project along with specifying terms of possible applications.

Name of the measure: Sedimentation ponds to reduce impact of soil erosion from forestry activities.

Description of the measure:

In order to reduce soil erosion impacts from forestry areas the sedimentation ponds are constructed on drainage ditches downstream the areas with forestry activities where clear-cutting is foreseen in considerable areas.[61]

Specification of the measure:

The main objective of the proposed measure is erosion control from forestry areas achieved by installation of hydro-technical constructions. Effect of the measure is prevention of hydro-morphological modifications of surface water bodies.

The sedimentation ponds have to be located on drainage ditches downstream the areas with forestry activities when they are close to place where collected drainage water enters into surface water body.

Taking into account that intensive soil erosion is observed 5 years after forestry activities are conducted, the installation of sedimentation ponds needs to be done before or shortly after the forestry activities. They don't need to be maintained after the negative effect of the activity (e.g. clear-cutting) disappears.

The proposed measure foresees the installation of sedimentation ponds in those surface water bodies were hydro-morphological alteration of the water body is recorded, and it should be installed not later than within 2 years period after forestry activities are conducted. Thus the measure is proposed as construction of sedimentation ponds in operating drainage systems.

This is the main difference from the similar measure LV14 (sedimentation ponds as part of the "environment friendly management of forest drainage systems"), which is proposed as installation of sedimentation ponds during constructing, renovating or reconstructing drainage

[61] Since a permit is required for clear-cutting the requirement for building a pond could be specified as part of the permitting process where appropriate.

systems, meaning that the sedimentation pond is installed to reduce impacts of large-scale areas not only particular places of forestry activities and is located before entering drainage waters to surface water body. Such sedimentation ponds are maintained permanently.

Sedimentation ponds are constructed by deepening and widening melioration systems. Their setting and configuration must support slowdown of water mass movement and sedimentation of soil particles suspended in water mass. During rainfalls and floods water velocity in such constructions must not exceed 0.3 m/sec.

Location and dimensions of the sedimentation ponds are designed with possibility of regular mechanical cleaning and removal of stored sediments as well as removal of excess overgrowth with water plants. Sedimentation ponds must have at least 3 meter in length, 1 meter in width and at least 0.5 meter deep. At its lower part a threshold preferably should be constructed to slow down water movement. Sedimentation ponds' dimensions are dependent from the forest felling area from which waters are received as well from the dominating soil types and related soil particle dimensions within the given catchment, as well in accordance with access possibilities and planned sediment removal regularity

Information sources used for the specification of the measure:

- Frelih-Larsen A., von der Weppen J. (2012) *Introduction to Factsheets on Environmental Effectiveness of Selected Agricultural Measures.* Developed by the project "Comparative study of pressures and measures in the major river basin management plans in the EU".
- Putting best agricultural practices into work. Project's Baltic Deal website: http://www.balticdeal.eu/measures/.
- Grīnberga L., Jansons V. (2012) *Mākslīgie mitrāji ūdens piesārņojuma samazināšanai.* LLU.
- Urtāne L. (red.) (2012) *Ūdensceļi un ūdensmalas. Vadlīnijas ūdenstilpju un ūdensteču izmantošanas un apsaimniekošanas plānošanai.* Vidzemes plānošanas reģions.
- Guidance on good practice in the management and creation of small waterbodies in Scotland. http://adlib.everysite.co.uk/adlib/defra/content.aspx?doc=11588&id=11619.
- Lauku attīstības programmas 2014.-2020.gadam stratēģiskais ietekmes uz vidi novērtējums.
- Zemkopības ministrijas dati http://www.zm.gov.lv/?sadala=434 .

Sedimentation ponds to reduce impact of soil erosion from agricultural lands (LV13)

This measure with the purpose and application as described here was not proposed in the 1st RBMPs. The sedimentation ponds were considered in the RBMPs under the measure for reducing hydro-morphological pressures named as *„Environment friendly management of drainage systems"*, which prescribes to apply established conditions (specified by „technical provisions" – see the measure LV18) of environment friendly hydro-technical construction when maintaining, constructing, renovating or reconstructing drainage systems. The sedimentation ponds as part of the "environment friendly management" of agricultural drainage systems are **not** proposed further (see the measure LV21).

Specification of the measure was not provided in the RBMPs, thus it was developed by the project.

Name of the measure: Sedimentation ponds to reduce impact of soil erosion from agricultural lands.

Description of the measure:

In order to reduce soil erosion impacts from agricultural lands the sedimentation ponds are constructed on drainage ditches downstream the areas of agricultural lands where soil erosion is recorded locating them either close to area with soil erosion or before collected drainage water enters into surface water body depending on characteristics of drainage system.

Text box 7:

Soil erosion (partial displacement of soil upper layer during rain and snow precipitation) is recorded in 15.4 % of arable lands in Latvia, which is approximately 380 000 hectares.

Specification of the measure:

The main objective of the proposed measure is erosion control from agricultural lands achieved by installation of hydro-technical constructions. Effect of the measure is prevention of hydro-morphological modifications of surface water bodies.

The sedimentation ponds are constructed in relation to those surface water bodies were soil erosion is observed and hydro-morphological alteration of water body is recorded. The installation of these hydro-technical structures minimise soil erosion effects and particularly sedimentation processes, as well as, prevent hydro-morphological modifications of water bodies.

The ponds have to be located on drainage ditches downstream the areas of agricultural lands where soil erosion is recorded locating them either close to area with soil erosion or before collected drainage water enters into surface water body depending from characteristics of drainage system. They are maintained permanently.

Technical specification of the sedimentation ponds for agricultural drainage systems do not differ from those of forest drainage systems (see the technical specification for the measure LV12).

Information sources used for the specification of the measure:

- Frelih-Larsen A., von der Weppen J. (2012) *Introduction to Factsheets on Environmental Effectiveness of Selected Agricultural Measures.* Developed by the project "Comparative study of pressures and measures in the major river basin management plans in the EU".
- Putting best agricultural practices into work. Project's Baltic Deal website: http://www.balticdeal.eu/measures/.
- Grīnberga L., Jansons V. (2012) *Mākslīgie mitrāji ūdens piesārņojuma samazināšanai.* LLU.
- Urtāne L. (red.) (2012) *Ūdensceļi un ūdensmalas. Vadlīnijas ūdenstilpju un ūdensteču izmantošanas un apsaimniekošanas plānošanai.* Vidzemes plānošanas reģions.
- Guidance on good practice in the management and creation of small waterbodies in Scotland. http://adlib.everysite.co.uk/adlib/defra/content.aspx?doc=11588&id=11619.
- Lauku attīstības programmas 2014.-2020.gadam stratēģiskais ietekmes uz vidi novērtējums.
- Zemkopības ministrijas dati http://www.zm.gov.lv/?sadala=434 .

Sedimentation ponds as part of environment friendly management of forest drainage systems (LV14)

The measure was considered in the 1st RBMPs under the measure for reducing hydro-morphological pressures named as *„Environment friendly management of drainage systems"*, which prescribes to apply established conditions (specified by „technical provisions" – see the

measure LV 17) of environment friendly hydro-technical construction when maintaining, constructing, renovating or reconstructing drainage systems.[62]

As part of this study, the sedimentation ponds were separated (included as a separate measure here) from other means of the "environment friendly management" and a proposal for specification of the measure was prepared by the project.

Name of the measure: Sedimentation ponds as part of environment friendly management of forest drainage systems.

Description of the measure:

In order to reduce soil erosion impacts from forest lands, when constructing, renovating or reconstructing forest drainage systems the sedimentation ponds are constructed to reduce impacts of large-scale areas not only particular places of forestry activities locating them before collected drainage water enters into surface water body.

Specification of the measure:

The main objective of the proposed measure is sedimentation control and soil erosion management achieved by installation of sedimentation ponds to minimise sedimentation processes and prevent hydro-morphological modifications of water bodies.

Installation of the sedimentation ponds is foreseen:

1. when public funding is used for construction of new drainage systems and renovation/reconstruction of existing drainage systems; and
2. for surface water bodies having the "risk" of failing GES.

As noted earlier, the main difference from the similar measure LV12 (sedimentation ponds to reduce impact of soil erosion) is that the ponds are proposed here to be installed during constructing, renovating or reconstructing drainage systems, which means that the sedimentation pond is installed before the forestry activities are conducted.

The sedimentation ponds must be located on drainage ditches downstream the areas with forestry lands locating them before collected drainage water enters into surface water body, and they are maintained permanently. Technical specification of the sedimentation ponds here do not differ from the measure LV12.

It should be noted that installation of the sedimentation ponds within forest land are applied in practice in the state owned forests in recent years. The company "Latvian State Forests" has approved standard (from 2010) for constructing sedimentation ponds when conducting construction works in relation to forest drainage systems. These ponds are aimed to limit sedimentation processes and to prevent hydro-morphological modifications of water bodies and particularly deterioration of river beds through siltation and disappearance of gravel beds.

Information sources used for the specification of the measure:

- Frelih-Larsen A., von der Weppen J. (2012) *Introduction to Factsheets on Environmental Effectiveness of Selected Agricultural Measures.* Developed by the project "Comparative study of pressures and measures in the major river basin management plans in the EU".
- Putting best agricultural practices into work. Project's Baltic Deal website: http://www.balticdeal.eu/measures/.
- Grīnberga L., Jansons V. (2012) *Mākslīgie mitrāji ūdens piesārņojuma samazināšanai.* LLU.

[62] In the 1st RBMP, the measure is proposed in 3 WBs of the Gauja RBD – G229 Vija, G268 Svētupe, G312 Rūja.

- Urtāne L. (red.) (2012) *Ūdensceļi un ūdensmalas. Vadlīnijas ūdenstilpju un ūdensteču izmantošanas un apsaimniekošanas plānošanai.* Vidzemes plānošanas reģions.
- Guidance on good practice in the management and creation of small waterbodies in Scotland. http://adlib.everysite.co.uk/adlib/defra/content.aspx?doc=11588&id=11619.

Improving ecological functionality of lakes (LV15)

Name, description and specification of the respective measure from the 1st RBMP for the Gauja RBD (see the Text box 8) are modified by the project based on expert knowledge and review of literature.

The measure was proposed in the 1st RBMP for the Gauja RBD in one lake WB only – E225 Burtnieku lake. **The measure is modified in a way that it could be applied in any other lake WB with similar environmental problems and "moderate" or worse status of ecological quality.**

Name of the measure: Improving ecological functionality of lakes.

Description of the measure: In order to improve ecological quality of lake water body specific activities are implemented aiming at improving the ecological processes of that lake.

Specification of the measure:

The main objective of the measure is nutrient management and control achieved by limitation of overgrowth with macrophytes in aquatic part of lake and/or with bushes in riparian part of lake.

The effect of this measure is reduction of nutrient load by cutting and removal of water plants and enforcement of self-purification capacity achieved by strengthening of wind and wave induced washout of material of organic origin (remnants of water plants, fallen leaves and twigs, sediment particles etc.).

The improvement of the ecological processes can be achieved by specific set of activities, which is applied to each particular lake depending on its specific environmental conditions (with prior investigation). The activities may include:

(1) Limitation of overgrowth with vegetation. The activity includes both cutting and removal of water plants. The effect of this activity is (i) reduction of nutrient load and (ii) enforcement of self-purification capacity, which is important to ensure further reduction of nutrient load. Activity targeted to nutrients' reduction must be undertaken from the 1st of July until the beginning of August. Activities targeted to strengthening of wind and wave effects may be conducted from the 1st of July until the 1st of October and primary is undertaken as cutting of water plants and opening of dominating wind affected lake shores to strengthen organic origin material washout on the shore and promote their further terrestrial mineralisation.

(2) Opening of lake shore sectors by removing bushes and single trees. The effect of this activity is enforcement of self-purification capacity through increased wave induced water saturation with oxygen. Activity primary is undertaken as cutting of bushes and opening of overgrown wind effect eliminating lake shore sectors to restart wave movement and increase oxygen saturation in water.

Text box 8:

Description of the measure according to the 1st RBMP for Gauja RBD:

Name of the measure: Reasonable lake management.

Description of the measure: To take reasonable lake management, including, mowing reeds regularly, cleaning up the banks of the bushes and, if necessary, removing the sediments from the parts of lake, where growth of reeds is not allowed.

Specification of the measure according to the programs of measures of the 1st RBMPs:

No other information than the description above is provided in the 1st RBMP.

The measure is proposed for one lake WB only – the Burtnieku lake.

(3) The reduction of nutrients' load originated within riparian part of lake. The effect of this activity is reduction of nutrient load originated as excessive leaf debris accumulation from trees and bushes within littoral part of the lake with further clogging of the biologically active coastal part of the lake. Activity is undertaken as selected cutting of bushes within 1-2 m wide riparian part of lake.

Other site specific activities (sediment removal, stabilization of hydrological regime etc.) may be identified on investigation bases.

Environment friendly management of forest and agricultural drainage systems (LV20 and LV21)

The measures were not clearly defined (nor specification provided) in the 1st RBMP, since they were thought to be specified by a national scale administrative measure included in the 1st programs of measures – *"Development of technical provisions for forest and agricultural drainage systems and polders"* (see the measures LV17-19).[63] Application of the established provisions (see the Text box 9) is considered in selected WBs of the Gauja RBD.[64] **The two measures specified further are recommended for such cases.**

Description of the measure was developed by the project based on review of literature and expert knowledge.

Name of the measures: Environment friendly management of forest and agricultural drainage systems.

Description of the measures:

In order to coordinate economic activities and protection of surface water, the environment friendly management of forest and agricultural drainage systems is introduced.

The term "management" is considered as construction of new drainage systems, renovation or reconstruction of existing drainage systems and regular maintenance of drainage systems required by existing legislation (*Amelioration Law, the Regulation of Cabinet of Ministers N^{o} 714 (from 03.08.2010*)).

Text box 9:

Description of the measures according to the 1st RBMP for Gauja RBD:

To apply established provisions of environmentally friendly hydro-technical construction when maintaining, constructing, renovating or reconstructing forest and agricultural drainage systems.

It was not clear from the RBMPs what pressure(s) are targeted by the measures (various parts of the RBMPs refer to different pressures e.g. nutrients' pollution and/or hydro-morphological pressures). In this study, the measure is renamed as "*environment friendly management of drainage systems*" considering activities for both pressures as appropriate.

The term "environmentally friendly management" is not applicable to conventional amelioration practice including uninterrupted deepening of ditches using heavy machinery, removing all coastal vegetation and possible obstacles in channel bed. The given term means

[63] Description of this measure provided in the 1st RBMPs: *"To develop provisions of environment friendly hydro-technical construction for constructing, renovating and reconstructing forest and agricultural drainage systems and for restorating or reconstructing polders or for maintenance of polder systems."* Taking into account that the description of the measure does not mention clearly "maintenance" of drainage systems (only "constructing, renovating ...") the description has been complemented that the provisions covers also "maintenance".

[64] G229 Vija, G268 Svētupe, G312 Rūja.

"soft management approach" and includes activities based on ecosystem functionality requiring site specific actions supporting connectivity of ditches (for example, leaving some macrophyte patches or single stones/their assemblages supporting hides and serving as further species dissemination areas/stepping stones etc.).

In relation to maintenance of drainage systems:

- ⇨ **Certain "soft management" approach and required activities for the maintenance are prescribed by the existing national regulations already**. However it is mostly not complied with in practice. Thus, the measures proposed here largely overlap with existing regulations but are seen as additional instrument for ensuring their application in practice.
- ⇨ **Detailed technical provisions for the "soft management approach" and the required activities need to be further specified (should be addressed by the measures LV17 and LV18).** General principles and types of the activities are specified below (see specifications for the measures LV20.2 and LV21.2).

Specification of the measures:

The main objectives of the measures are sedimentation control and erosion management and nutrient management.

Environment friendly management of forest drainage systems (LV 20)

The measure considers carrying out specific activities when maintaining, constructing, renovating or reconstructing forest drainage systems.

Concerning **construction and renovation** of forest drainage systems the installation of specific hydro-technical structures – sedimentations ponds is foreseen. This measure is considered as a separate measure in this study – **see the measure LV14.** The sedimentation ponds must be located on drainage ditches downstream the areas with forestry activities locating them before collected drainage water enters into surface water body, and they are maintained permanently. They are installed:

1. when public funding is used for construction of new drainage systems and renovation/reconstruction of existing drainage systems; and
2. for surface water bodies having the "risk" of failing GES.

(Refer to the measure LV14 for more detailed technical specification of the sedimentation ponds.)

Concerning **maintenance** of drainage system in "environment friendly" way **(LV20.2)**, this should include:

1. Cleaning of drainage system from bushes and trees rooting in channel bed, wooden debris and fallen trees. The effects of this activity are (i) assurance of designed runoff capacity, which is important to keep functionality of drainage system, and (ii) prevention of deterioration of water quality and hydro-morphological condition of water bed resulted by blocking of water course.
2. Limitation of beaver activities by destruction of beaver dams. The effects of this activity are (i) assurance of projected runoff capacity, which is important to keep functionality of drainage system, and (ii) prevention of deterioration of water quality and hydro-morphological condition of water bed resulted by stopped water flow.

Environment friendly management of agricultural drainage systems (LV 21)

The measure considers carrying out specific activities when maintaining, constructing, renovating or reconstructing agricultural drainage systems.

Concerning the **construction and renovation** of agricultural drainage systems the installation of specific hydro-technical structures – nutrients' retention ponds is foreseen **(LV21.1)**. The nutrients' retention ponds are located before collected drainage water is entering into surface water body to prevent intensifying of nutrient loads from a catchment, and they are maintained permanently. The nutrient's retention ponds are considered also as a separate measure in this study – see the measure LV11. Unlike for the measure LV11, when the nutrients' retention ponds are proposed to be constructed on operating drainage systems, their installation is considered here during the construction/reconstruction/ renovation of drainage systems:

1. when public funding is used for construction of new drainage systems and renovation/reconstruction of existing drainage systems; and
2. for surface water bodies having the "risk" of failing GES.

(Refer to the measure LV11 for more detailed technical specification of the nutrients' retention ponds.)

Concerning **maintenance** of drainage system in "environment friendly" way **(LV21.2)**, this should include:

1. Limitation of overgrowth with vegetation by regular cutting and removal of water plants. The effects of this activity are (i) assurance of designed runoff capacity, which is important to keep functionality of drainage system, and (ii) enforcement of self-purification capacity, which is important to ensure reduction of nutrient load.
2. Limitation of total overgrowth with bushes by regular cutting of bushes on banks of drainage systems creating mosaic bank vegetation. The effects of this activity are (i) assurance of designed runoff capacity, which is important to keep functionality of drainage system, and (ii) limitation of beaver activities, which is important to prevent deterioration of water quality and hydro-morphological condition of water bed resulted by blocking of water course.
3. Naturalization of channel bed by installing separate stones or their assemblages. The effect of this activity is enforcement of self-purification capacity, which is important to ensure reduction of nutrient load as well as to increase potential biodiversity. The activity should ensure that requirements of water runoff capacity required by the existing Legislation (*Amelioration Law, the Regulation of Cabinet of Ministers N^{o} 714 (form 03.08.2010)*) are taken into account.

It should be noted that there are recent examples of implementing various technical solutions for sediment and nutrient flows reduction in agricultural drainage ditches in Latvia. More information about these experiences can be obtained from projects Baltic Deal, Meatball, SNOWBAL. For instance:

Project Baltic Deal: http://www.llkc.lv/lv/nozare/projekti-baltic-deal

Latvian Fund for Nature, project MEATBALL: http://www.ldf.lv/pub/?doc_id=29808.

These experiences should be looked closer to complement knowledge and information base for the proposed measure (incl. on effect, costs, technical specification of measure).

Information sources used for the specification of the measure:

- Programs of measures of the 1st RBMPs (2010).
- Progress reports on implementation of the WFD Programmes of measures in Latvia (2012).
- Putting best agricultural practices into work. Project's Baltic Deal website: http://www.balticdeal.eu/measures/.

- Grīnberga L., Jansons V. (2012) *Mākslīgie mitrāji ūdens piesārņojuma samazināšanai.* LLU.
- Urtāne L. (red.) (2012) *Ūdensceļi un ūdensmalas. Vadlīnijas ūdenstilpju un ūdensteču izmantošanas un apsaimniekošanas plānošanai.* Vidzemes plānošanas reģions.
- Guidance on good practice in the management and creation of small waterbodies in Scotland. http://adlib.everysite.co.uk/adlib/defra/content.aspx?doc=11588&id=11619.

Improving ecological functionality of regulated rivers (LV26 and LV27)

The measures were not clearly defined (nor description provided) in the 1st RBMP, since they were thought to be specified after research & administrative (set of) measures (included in the 1st program of measures – see the measure "*Investigation about measures for regulated rivers"* (LV16)[65]), which is considered for selected river WBs in the Gauja RBD.[66] **The two measures specified further are possible options recommended for such cases.**

Description of the measures was developed by the project based on review of literature and expert knowledge.

Name of the measures: Improving ecological processes when maintaining regulations of rivers (LV26) and improving ecological functionality of regulated rivers by naturalisation of river bed (LV27).

Description of the measures: In order to coordinate economic activities and protection of surface waters, the improvement of ecological processes of regulated rivers is introduced.

Specification of the measures:

The main objectives of the measures are nutrient control and management achieved by regular maintenance of a regulated river and naturalization of river bed.

The effects of these measures are enforced self-purification capacity, reduction of nutrient load and establishment of aquatic communities normally associated within definite type of water body.

There are many ways to improve ecological processes of regulated rivers. These methods range from "soft" to "hard" approaches. "Soft" methods are preferred and include limitation of overgrowth (with water plants in aquatic part of surface water objects and/or with bushes in riparian part of surface water objects), improvement of in-stream structures, sediment transport management etc., while "harder" methods include establishment of historical river bed, removal of artificial bank structures etc. The proposed measures consider use of the "soft" methods and are regarded mainly to environment friendly maintenance of regulated rivers.

The conventional amelioration practice when uninterrupted deepening of watercourses using heavy machinery, removing all coastal vegetation and possible obstacles in river may not be considered as improvement of ecological processes in regulated rivers. The given measures are considered as "soft management approach" and include activities based on ecosystem functionality requiring site specific actions supporting connectivity of watercourses (for example, leaving some macrophyte patches or single stones/their assemblages supporting hides and serving as further species dissemination areas/stepping stones etc.).

[65] Description of this measure provided in the 1st RBMP of the Gauja RBD: *"To conduct investigation and to prepare proposals for restoration (re-meandering) of regulated rivers or sections of rivers and for restoration (creation) of overfalls [straujteces], where appropriate."*

[66] G206 Brasla, G242 Vizla/Jaunpalsa, G262 Pēterupa, G264 Aģe, G265 Rīgas j.l., G268 Svētupe.

In relation to maintenance of regulations of rivers (LV26):

- ⇨ **Certain "soft management" approach and required activities for the maintenance are prescribed by the existing national regulations already**. However it is mostly not complied with in practice. Thus, the measures proposed here largely overlap with existing regulations but are seen as additional instrument for ensuring their application in practice.
- ⇨ **Detailed technical provisions for the "soft management approach" and the required activities need to be further specified (should be addressed by the measure LV16 and, in particular, LV18).** General principles and types of the activities are specified below (see specifications for the measure LV26).

Improving ecological processes when maintaining regulations of rivers (LV26)

The regular maintenance of regulated rivers is required by existing legislation (*Amelioration Law; Cabinet Ministers regulation No. 714; 03.08.2010*).

The conventional practice of cleaning of regulated rivers should only be undertaken where it is necessary to clear drainage outfalls. Where maintenance of regulated rivers is required it should be undertaken in rotation to avoid excessive lengths of cleared vegetation and allow natural re-growth. Improvement of ecological processes of regulated rivers during their regular maintenance includes the following set of activities that are applied always when conducting the maintenance works:

(1) Limitation of overgrowth with vegetation by regular cutting and removal of water plants. The effects of this activity are (i) assurance of designed run-off capacity, which is important to keep functionality of regulated river being element of the *State water drainage system* (in Latvian – *Valsts nozīmes ūdensnoteka*), (ii) enforcement of self-purification capacity, which is important to ensure reduction of nutrient load and continuous water flow and (iii) minimised raise of water table and intensification of coastal erosion processes. Activity is undertaken in cases when overgrowth with water plants exceeds 30% of the surface area.

(2) Limitation of total overgrowth with bushes by management of protected belts creating mosaic bank vegetation. The effects of this activity are (i) assurance of designed runoff capacity, which is important to keep functionality of regulated river being element of the *State water drainage system* (in Latvian – *Valsts nozīmes ūdensnoteka*) and (ii) prevention of deterioration of water quality and hydro-morphological condition of water bed resulted by blocking of water course.

(3) Naturalization of river bed by installing separate stones or their assemblages. The effect of this activity is enforcement of self-purification capacity which is important to ensure reduction of nutrient load as well to increase potential biodiversity. The Activity should ensure that requirements of water runoff capacity required by the existing Legislation (*Amelioration Law; Cabinet Ministers regulation No. 714; 03.08.2010*) are taken into account.

Improving ecological functionality of regulated rivers by naturalisation of river bed (LV27)

The activities carried out in each case are site specific and needs to be determined after investigating each case. They may include the following activities:

(1) Improvement of in-stream structures is dedicated as restoration of hydro-morphological condition of the river bed to improve functionality of aquatic habitats. Habitat restoration can be achieved by cleaning of river from excessive wooden debris and fallen trees and/or by the placement of single stones and/or development of riffle areas.

(2) Restoration of banks refers mainly to rehabilitation of naturally degraded banks and the management of bank stability and erosion. Methods used include bank re-profiling, the creation of aquatic ledges and the re-establishment of natural vegetation.

(3) Sediment transport management refers to habitat restoration achieved via gravel replenishment and sand traps. Installation of sand traps is assumed as one of most effective methods to limit negative effects of sedimentation processes which are becoming an acute issue in Latvia. One of objectives of this activity is re-establishment of spawning areas for salmonid fishes where proportion of sand and gravel is limiting factor for spawning success.

- Gravel replenishment is used to compensate for altered sediment and flow regimes in regulated rivers. This measure seeks to replenish the stream's sediment budget deficit by importing sediment. Typical practice is dumping clean spawning gravels into piles along the edges of a river at locations upstream of degraded spawning habitat reaches (usually just downstream of a dam). It is assumed that augmented gravels will be entrained during high flows with the competence to transport them downstream. The technique relies on an adequate supply of gravel from upstream and an active bed load transport regime to deliver it.
- Sand traps are used to remove excess sediment from streams. A sand trap can consist of a depression dug into the stream channel where suspended sand settles. The deposited sediment must subsequently be removed which requires machinery. Excessive sand is detrimental to in-stream biota and in many cases is caused by the soil erosion processes from intensively used agriculture land without soil protection measures (sedimentation ditches or agricultural land buffer zones). Sand covers the gravel beds decreasing the availability and quality of bed habitats.

Information sources used for the specification of the measures:

- Kampa E., Stein U. (2012) *Final factsheets on Environmental Effectiveness of Selected Hydromorphological Measures*. Prepared by the project "Comparative Study of Pressures and Measures in the Major River Basin Management Plans".
- Urtāne L. (red.) (2012) *Ūdensceļi un ūdensmalas. Vadlīnijas ūdenstilpju un ūdensteču izmantošanas un apsaimniekošanas plānošanai.* Vidzemes plānošanas reģions.
- Urtāns A. (2010) *Padomi akmeņu ievietošanai upēs un straujteču veidošanai.* Projekts "Klimata izmaiņas: Ietekme, izmaksas un pielāgošanās Baltijas jūras reģionā.
- Urtāns A., Urtāne L. (2011) *Praktiski padomi kā uzlabot ūdensteču funkcionalitāti.* http://www.gwp.org/Global/ToolBox/Case%20Studies/Europe/Latvia.%20Practical%20methods%20to%20manage%20small%20rivers;%20ecosystem%20approaches%20applied%20(%23412).pdf.

Management of Protected Belts of water courses/bodies (LV28)

The measure was not proposed in the 1st RBMPs. But the need for such additional measure to reduce hydro-morphological pressures was identified during implementation of other tasks of the project, in particular, the task *"Evaluation of methodologies used for estimation of hydro-morphological pressures"*.

The description of the measure has been developed by the project based on review of literature and expert knowledge.

It should be noted that the measure do not address directly the pressures from agriculture or forestry (the focus of this study). It addresses **additional pressure to water bodies caused by lack of appropriate management of the Protected Belts.** However, where this problem exists, the measures for reducing pressures from agriculture and/or forestry would not give the expected improvement in status of water bodies without addressing this problem also. Moreover the measure can be applied in other cases where this problem causes water bodies to fail reaching GES.

Name of the measure: Management of Protected belts of water courses/bodies.

Description of the measure:

In order to reduce hydro-morphological and nutrients' pollution pressures caused by lack of maintenance of the Protected Belt of water courses/bodies their appropriate management is conducted.

Specification of the measure:

The main objectives of the measure is nutrient management, sediment control, erosion management and water flow management achieved by appropriate management of riparian zone of water courses/bodies defined as Protected Belts (according to the *Law on Protection Zones*).

The effect of this measure is prevention of hydro-morphological modifications of water courses, increase of nutrient accumulation capacity within riparian zone of water courses/water bodies and reduction of nutrient loads.

Simple removal of non-point and point pollutants is not enough to improve the ecological quality of surface water body. A balanced, integrated and adaptive communities of riparian/aquatic organisms must be re-established and capacity for self-repair also must be stimulated to reach good ecological conditions of surface water bodies.

The repair of the aquatic ecosystems through re-establishment of riparian zone by an appropriate management of Protected Belts should consider the following:

(1) Creation of mosaic overgrowth. The effect of this activity is (i) the achievement of stable equilibrium of sediment interception in grass/bush coverage which is very important to reduce nutrient leakage and soil erosion during November-March in leafless vegetation period, (ii) mitigation of coastal erosion processes and (iii) establishment of favourable conditions for shading balance. Activity is undertaken in selected pattern within Protected Belt by selected cutting of bushes.

(2) Limitation of potential blocking of river channel. The effect of this activity is mitigation of tree jam in river by removal of collapsing trees. Activity is undertaken as removal of over-aged Grey alder (*Alnus incana*) stands within 1–2 m wide zone along the river.

(3) Reduction of nutrients' load originated within riparian part of river. The effect of this activity is reduction of nutrient load originated as excessive leaf debris from trees and bushes accumulating and clogging the river bed. Activity is undertaken as selected cutting of bushes within 1-2 m wide riparian part of river.

Information sources used for the specification of the measure:

- Urtāne L. (red.) (2012) *Ūdensceļi un ūdensmalas. Vadlīnijas ūdenstilpju un ūdensteču izmantošanas un apsaimniekošanas plānošanai.* Vidzemes plānošanas reģions.
- Urtāns A. (2010) *Padomi akmeņu ievietošanai upēs un straujteču veidošanai.* Projekts "Klimata izmaiņas: Ietekme, izmaksas un pielāgošanās Baltijas jūras reģionā.
- Urtāns A., Urtāne L. (2011) *Praktiski padomi kā uzlabot ūdensteču funkcionalitāti.* http://www.gwp.org/Global/ToolBox/Case%20Studies/Europe/Latvia.%20Practical%20methods%20to%20manage%20small%20rivers;%20ecosystem%20approaches%20applied%20(%23412).pdf.
- Edited by Cowx I.G. and Welcomme R.L. (1998) *Rehabilitation of rivers for fish.* A study undertaken by the European Inland Fisheries Advisory Commission of FAO.
- Welch D.J. (1991) *Riparian forest buffers. Function and Design for Protection and Enhancement of Water Resources*.
- O'Grady M.F. (2006) *Channels & Challenges: enhancing Salmonid rivers*. // Irish Freshwater Fisheries Ecology & Management Series, N^{o} 4. Central Fisheries Board, Dublin, Ireland.

Annex 4: Assessments of environmental (water-related) effects of the measures

Table 1. Assessments of the environmental (water-related) effects of the measures developed as part of the study. *(Source: Various information sources, the assessments developed by the project's experts, in particular, L. Urtane from "L.U. Consulting".)*

Notes: "-" no direct impact on reducing pressure/improving state, "NK" effect could not be assessed due to lack of information. Assessment scale for the "Targeted effect": from "1" meaning "very low load reduction efficiency" to "5" meaning "very high load reduction efficiency". Assessment scale for the "Multiple effects": from "1" meaning "low" to "5" meaning "high" multiple effects. See the chapters 4.4.2 and 4.6 for more detailed explanations of these scales and assessments.

[1] The "targeted effect" of each measure in terms of the water quality element is marked with light green colour in this section of the table.

[2] See the chapter 4.4.2 for more information about the assessment of the "targeted effect" for the criterion 1 ("Cost-effectiveness of measures").

[3] See the chapter 4.6 for more information about the assessment of the "multiple effects" for the criterion 3 ("Multiple effects of measures").

ID	Name	Water quality problem (targeted)	Pressure (targeted)	Acti-vity	Effect on WFD quality elements: Chemical and physico-chemical [1]			Effect on WFD quality elements: Hydro-morphological elements [1]			Assessment of "Targeted effect" of a measure (for C1) [2]	Assessment of "Multiple effects" of a measure (for C3) [3]
					Nutrients (N, P)	Specific substances	Other elements	Hydrolog. regime	Continuity (for rivers)	Morphology		
LV1	**Arranging environmentally safe manure storage facilities**	Nutrients	Point	AGR	5	-	1	-	-	-	5	1
LV2	**Construction of biological WWTP in dairies**	Nutrients	Point	AGR	4 (for N), 5 (for P)	-	1	-	-	-	4 (for N), 5 (for P)	1
LV3	**Crop fertilisation planning**	Nutrients	Diffuse	AGR	3	-	1	-	-	-	3	1
LV4	**Winter green areas and stubble fields**	Nutrients	Diffuse	AGR	4	1	1	-	-	-	4	1
LV5	**Green manure**	Nutrients	Diffuse	AGR	3	1	1	-	-	-	3	1
LV6.1	**Agricultural land buffer zones for water courses and bodies**	Nutrients	Diffuse	AGR	2 (for N for 8m), 5 (for N for 16m); 5 (for P for 8m and wider)	2	3	-	-	5	2 (for N for 8m), 5 (for N for 16m); 5 (for P for 8m and more)	3
LV6.2	**Agricultural land buffer zones for drainage systems**	Nutrients	Diffuse	AGR	1	2	3	-	-	5	1 (for N) 1 (for P)	3

ID	Name	Water quality problem (targeted)	Pressure (targeted)	Acti-vity	Effect on WFD quality elements: Chemical and physico-chemical [1]			Effect on WFD quality elements: Hydro-morphological elements [1]			Assessment of "Targeted effect" of a measure (for C1) [2]	Assessment of "Multiple effects" of a measure (for C3) [3]
					Nutrients (N, P)	Specific substances	Other elements	Hydrolog. regime	Continuity (for rivers)	Morphology		
LV7	**Good felling practice**	Nutrients	Diffuse	FOR	4	-	3	-	-	3	4	3
LV8	**Forest buffer zones**	Nutrients	Diffuse	FOR	3	-	3	-	-	4	3	3
LV9	**Proposals to reduce impact of agricultural activities**	Nutrients	Diffuse	AGR	-	-	-	-	-	-	-	-
LV10	**Research and proposals for lakes with unknown reason "at risk"**	NK	Various	NK	-	-	-	-	-	-	-	-
LV11 (AD)	**Nutrients' retention ponds in AGR drainage systems**	Nutrients	Diffuse	AGR	2 (for N) 4 (for P)	2	3	-	-	3	2 (for N) 4 (for P)	3
LV12 (AD)	**Sedimentation ponds to reduce impact of soil erosion from FOR activities**	Hydro-morph	Soil erosion	FOR	3	-	3	-	-	5	5	4
LV13 (AD)	**Sedimentation ponds to reduce impact of soil erosion from AGR lands**	Hydro-morph	Soil erosion	AGR	3	1	4	-	-	5	5	4
LV14 (AD)	**Sedimentation ponds as part of environment friendly management of FOR drainage systems**	Hydro-morph	Soil erosion	FOR	3	-	3	-	-	5	5	4
LV15	**Improving ecological functionality of lakes**	Nutrients	Diffuse	OTH	from 2 to 5	-	3	4	-	4	from 2 to 5	4
LV16	**Investigation about measures for regulated rivers**	Hydro-morph	Straightening	AGR	-	-	-	-	-	-	-	-
LV17	**Development of technical provisions for FOR drainage systems**	Hydro-morph, Nutrients	Drainage	FOR	-	-	-	-	-	-	-	-
LV18	**Development of technical provisions for AGR drainage systems**	Hydro-morph, Nutrients	Drainage	AGR	-	-	-	-	-	-	-	-
LV19	**Development of technical provisions for polders**	Hydro-morph	Polders	AGR	-	-	-	-	-	-	-	-

ID	Name	Water quality problem (targeted)	Pressure (targeted)	Acti-vity	Effect on WFD quality elements: Chemical and physico-chemical [1]			Effect on WFD quality elements: Hydro-morphological elements [1]			Assessment of "Targeted effect" of a measure (for C1) [2]	Assessment of "Multiple effects" of a measure (for C3) [3]
					Nutrients (N, P)	Specific substances	Other elements	Hydrolog. regime	Continuity (for rivers)	Morphology		
LV20	**Environment friendly management of FOR drainage systems**	Hydro-morph	Drainage	FOR	3 or 1	-	3 or 1	3 or 1	3 or 1	3 or 1	For [LV20.2]: 3 (if beaver caused problems exist) 1 (if only Act.1 is needed)	3 or 4
LV21	**Environment friendly management of AGR drainage systems**	Nutrients	Drainage	AGR	For [LV21.1]: 2 (for N), 4 (for P) For [LV21.2]: 3 (for N and P)	1	3	3	-	4	For [LV21.1]: 2 (for N), 4 (for P) For [LV21.2]: 3 (for N and P)	4
LV22	**Environment friendly management of polder systems**	Hydro-morph	Polders	AGR	NK	NK	NK	NK	NK	NK	NK	NK (Actual measures are not specified yet.)
LV23	**Development of River Basin Management Information system**	ALL	Various	OTH	-	-	-	-	-	-	-	-
LV24	**Educational and Informational measures**	ALL	Various	OTH	-	-	-	-	-	-	-	-
LV25	**Organising public participation**	ALL	Various	OTH	-	-	-	-	-	-	-	-
LV26 (AD)	**Improving ecological processes when maintaining regulations of rivers**	Hydro-morph	Straightening	AGR	3	-	2	3	2	4	3	4

ID	Name	Water quality problem (targeted)	Pressure (targeted)	Acti-vity	Effect on WFD quality elements: Chemical and physico-chemical [1]			Effect on WFD quality elements: Hydro-morphological elements [1]			Assessment of "Targeted effect" of a measure (for C1) [2]	Assessment of "Multiple effects" of a measure (for C3) [3]
					Nutrients (N, P)	Specific substances	Other elements	Hydrolog. regime	Continuity (for rivers)	Morphology		
LV27 (AD)	**Improving ecological functionality of regulated rivers by naturalisation of river bed**	Hydro-morph	Straightening	AGR	3	-	2	4	2	5	5	4
LV28 (AD)	**Management of Protected Belts of water courses/bodies**	Hydro-morph, Nutrients	Other	OTH	5	"-" (for FOR lands) 2 (for AGR lands)	4	5	5	4	5	5

Annex 5: Assessment of positive "environment-related side effects" of the measures

Table 1. Assessment of the positive "environment-related side effects" of the measures developed as part of the study. *(Source: Various information sources, the assessment developed by the project's expert L. Urtane from "L.U. Consulting".)*

Abbreviations: TE – terrestrial ecosystems, GW – groundwater, SQ – soil quality, AQ – air quality, LQ – landscape quality, FC – flood control, WBD – biodiversity in additional water biotope, SUM – number of positively affected elements of the environment.

Effect of each measures is assessed with "Yes"/"No" or NK (effect could not be assessed due to lack of information).

The measures with no direct effect on reducing pressures/improving state are not included in the table.

Name of measure	TE	GW	SQ	AQ	LQ	FC	WBD	SUM	Comments on the effects
LV1 Arranging environmentally safe manure storage facilities	Yes	Yes	Yes	Yes	No	No	No	**4**	Reduced nutrient leaching from manure storage has positive effects on (i) biodiversity by reduction of eutrophication processes leading simplification of vegetation; (ii) prevention of groundwater pollution; (iii) improvement of soil quality; (iv) may improve air quality by reduced NH^3 emissions.
LV2 Construction of biological WWTP in dairies	No	Yes	No	No	No	No	No	**1**	Reduced P load to the environment has positive effect on prevention of groundwater pollution.
LV3 Crop fertilisation planning	No	Yes	Yes	No	No	No	No	**2**	Reduced amount of used nutrients has positive effects on (i) prevention of groundwater pollution; (ii) improvement of soil quality.
LV4 Winter green areas and stubble fields	Yes	Yes	Yes	Yes	No	No	No	**4**	Positive effects on (i) biodiversity by creating additional food recourses; (i) prevention of groundwater pollution; (iii) improvement of soil quality by improved soil cover, reduced soil erosion, improved soil organic matter, carbon sequester in the soil etc. and (iv) may improve air quality by reduced N_2O emissions.
LV5 Green manure	Yes	Yes	Yes	No	No	No	No	**3**	Positive effects on (i) biodiversity by improved structure of terrestrial vegetation and reduction of eutrophication processes leading simplification of vegetation; (ii) prevention of groundwater pollution; (iii) improvement of soil quality by enhanced soil cover, reduced soil erosion, improved soil organic matter.
LV6 Agricultural land buffer zones for LV6.1 water courses and bodies LV6.2 drainage systems	Yes	Yes	Yes	No	Yes	No	No	**4**	Positive effects on (i) biodiversity by creating "ecological corridors" and reduction of eutrophication processes leading simplification of vegetation; (ii) prevention of groundwater pollution; (iii) improvement of soil quality by enhanced soil cover, reduced soil erosion, improved soil organic matter, carbon sequester in the soil etc.; (iv) landscape quality.
LV7 Good felling practice	Yes	No	Yes	No	No	No	No	**2**	Positive effects on (i) biodiversity by improved structure of terrestrial vegetation and reduction of eutrophication processes leading simplification of vegetation; (ii) improvement of soil quality by enhanced soil cover, reduced soil erosion, improved soil organic matter, carbon sequester in the soil etc.

Name of measure	TE	GW	SQ	AQ	LQ	FC	WBD	SUM	Comments on the effects
LV8 Forest buffer zones	Yes	No	Yes	No	Yes	No	No	**3**	Positive effects on (i) biodiversity by improved structure of terrestrial vegetation and reduction of eutrophication processes leading simplification of vegetation; (ii) improvement of soil quality by enhanced soil cover, reduced soil erosion, improved soil organic matter, carbon sequester in the soil etc.; (iii) landscape quality.
LV11 (AD) Nutrients' retention ponds in AGR drainage systems	No	Yes	Yes	Yes	Yes	Yes	Yes	**6**	The M. results in installation of new WB, therefore has positive effects on (i) biodiversity in additional water biotope; (ii) prevention of groundwater pollution and recharge of groundwater; (iii) improvement of soil quality by reduced soil erosion; (iv) may contribute to reduction of annual CO_2 emissions; (v) provide natural flood control in areas at risk of downstream flooding; (vi) has positive impact on landscape by bringing variations to agricultural landscape; (vii) enhance the value of recreational areas and increase tourism potential.
LV12 (AD) Sedimentation ponds to reduce impact of soil erosion from FOR activities	No	No	No	No	No	No	Yes	**1**	The M. results in installation of new WB, therefore has positive effects on biodiversity in additional water biotope.
LV13 (AD) Sedimentation ponds to reduce impact of soil erosion from AGR land	No	No	No	No	Yes	No	Yes	**2**	The M. results in installation of new WB, therefore has positive effects on (i) biodiversity in additional water biotope; (ii) landscape by bringing variations to agricultural landscape.
LV14 (AD) Sedimentation ponds as part of environment friendly management of FOR drainage systems	No	No	No	No	No	No	Yes	**1**	The M. results in installation of new WB, therefore has positive effects on biodiversity in additional water biotope.
LV15 Improving ecological functionality of lakes	Yes	No	No	No	Yes	No	No	**2**	Positive effects on (i) biodiversity by improved structure of terrestrial vegetation and reduction of eutrophication processes leading simplification of vegetation; (ii) landscape quality.
LV20 Environment friendly management of FOR drainage systems (LV20.2)	No	No	No	No	Yes	No	No	**1**	[For LV20.2] Positive effects on the landscape quality.
LV21 Environment friendly management of AGR drainage systems (LV21.1 and 21.2)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	**7**	[For LV21.1] The same as for LV11. [For LV21.2] Positive effects on (i) biodiversity by improved structure of terrestrial vegetation; (ii) improvement of soil quality by reduced soil erosion; (iii) landscape quality.
LV22 Environment friendly management of polder systems	NK	NK	NK	NK	NK	NK	NK	**NK**	Actual measures are not specified yet.

Name of measure	TE	GW	SQ	AQ	LQ	FC	WBD	SUM	Comments on the effects
LV26 (AD) Improving ecological processes when maintaining regulations of rivers	Yes	No	No	No	Yes	Yes	No	**3**	Positive effects on (i) biodiversity by improved structure of terrestrial vegetation; (ii) provide natural flood control in areas at risk of downstream flooding; (iii) have a positive impact on landscape by bringing variations to agricultural landscape.
LV27 (AD) Improving ecological functionality of regulated rivers by naturalisation of river bed	Yes	No	Yes	No	Yes	Yes	No	**4**	Positive effects on (i) biodiversity by improved structure of terrestrial vegetation; (ii) improvement of soil quality by reduced soil erosion; (iii) provide natural flood control in areas at risk of downstream flooding; (iv) have a positive impact on landscape by bringing variations to agricultural landscape.
LV28 (AD) Management of Protected belts of water courses/bodies	Yes	Yes	Yes	No	Yes	Yes	No	**5**	Positive effects on (i) biodiversity by improved structure of terrestrial vegetation and improved quality of "ecological corridors"; (ii) prevention of groundwater pollution; (iii) improvement of soil quality by enhanced soil cover, reduced soil erosion, improved soil organic matter, carbon sequester in the soil; (iv) provide natural flood control in areas at risk of downstream flooding; (iv) have a positive impact on landscape by bringing variations to agricultural landscape.