IMPROVING THE ENVIRONMENTAL QUALITY OF THE BLACK SEA THROUGH BETTER WASTE WATER TREATMENT & CLIMATE CHANGE ADAPTATION OF THE WATER SECTOR IN MOLDOVA

Analysis of selected adaptation measures and a feasible adaptation strategy for WSS in Moldova (Task 2)

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List of Abbreviations and Selected Terms

AAM	Agency Apele Moldovei (Water Agency)
EAP Task Force	Environmental Action Programme Task Force
EC	European Commission
EEA	European Environment Agency
EECCA	Eastern Europe, Caucasus and Central Asia
EIB	European Investment Bank
ENVSEC	Environment and Security Initiative
EU	European Union
EUR	Euro (currency of the European Monetary Union)
EUWI	European Union Water Initiative
GoM	Government of Moldova
LPA	Local Public Administration
MEnv	Ministry of Environment
MDL	Moldovan lei (national currency)
NCCAS	National Climate Change Adaptation Strategy of Moldova
NCPH	National Centre for Public Health
NEF	National Ecological Fund
NFRD	National Fund for Regional Development
NHDR	National Human Development Report
NPD	National Policy Dialogue
OECD	Organisation for Economic Co-operation and Development
O&M	operation and maintenance
PIU	Project Implementation Unit
RARD	Regional Agency for Regional Development
RM	Republic of Moldova
SDC	Swiss Agency for Development and Cooperation
SHS	State Hydrometeorological Service
Water SPSP	Sector Policy Support Programme for WSS in Moldova (EC-funded)
SRES	Special Report on Emissions Scenarios
TA Water SPSP	Technical Assistance for the Implementation of the Water SPSP (ongoing EC-funded project: EuropeAid/130872/C/SER/MD Contract 2011/270-593)
UNDP	United Nations Development Programme
WHO	World Health Organization
WQI	Water Quality Index
WS	Water Supply
WSS	Water Supply & Sanitation
WTP	Water Treatment Plant
WWTP	Waste Water Treatment Plant

1 EUR = 16 MDL *(average exchange rate used in this report)*

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The views expressed herein are those of the authors and can in no way be taken to reflect the official opinion of the European Union, the Government of Moldova, or the Organisation for Economic Co-operation and Development.

Any errors and omissions in this report are those of the authors.

Table of Contents

Executive summary

The present document constitutes a component (Task 2) of the project *"IMPROVING THE ENVIRONMENTAL QUALITY OF THE BLACK SEA THROUGH BETTER WASTE WATER TREATMENT & CLIMATE CHANGE ADAPTATION OF THE WATER SECTOR IN MOLDOVA"*. The project is sponsored by EC (DG ENV) and OECD and implemented by a consortium led by Kommunalkredit Public Consulting. The project comprises three tasks. The tasks are implemented through a National policy dialogue with senior policy-makers in Moldova, in the framework of the EU Water Initiative (EUWI).

The first task involves the assessment of the impacts of climate change on water resources and water supply and sanitation (WSS) systems in Moldova. Task 2 analyses selected adaptation measures for inclusion in a feasible adaptation strategy. Task 3 reviews viable organisational models for rural water supply and sanitation.

The purpose of the present document is to provide input into the revision of Moldova's WSS Sector Strategy (supported by the EC-funded TA Water SPSP), including a mid-term Action plan, and to the National Climate Change Adaptation Strategy (supported by the UNDP). Analyses build on Task 1 and on a preliminary inventory of adaptation measures for water supply and sanitation in Moldova.

This document provides input to other initiatives as well, such as the National Plan for Flood Protection and a national plan for reducing risks of other natural hazards (e.g. droughts).

The **first chapter** sums up the conclusions from the Task 1 Report. These include projected impacts of climate change on water availability and quality:

- **Precipitation** – while overall precipitation is expected to remain close to past figures, the variability of this precipitation over the year is expected to increase dramatically, contributing to floods and droughts.
- **Surface water quantity** – climate change models conclude average run-offs of the surface water, including the rivers Prut and Dniester, will decrease by 2020 on average by 13% or even 16 – 20%[1] (depending on the modelling scenarios), while peak flows will increase, thus increasing the risks of floods and droughts.
- **Decreasing annual surface water runoffs and reduced ground water recharge** combined with the ambitious target of national economic development will lead to water scarcity in the 2020s or in the 2030s (when considering both surface and ground water) [2]
- **Surface water quality** – during droughts, surface water quality is expected to decline (involving decreased concentrations of dissolved oxygen and increased concentrations of N-ammonium, etc.). During floods, the concentrations of suspended solids and sediments are expected to increase.
- **Shallow water** –some 50% of the population of Moldova use shallow wells as a main source of water supply. During droughts – for example, as seen in 2007 and 2012 – the water tables lower and many shallow wells dry out, threatening the security of water supply in affected villages.

[1] National Human Development Report. Climate Change in Moldova, 2009/2010

[2] ibid

- **WSS sector infrastructure** – during floods, affected pumping stations stop operating and water mains can be damaged, capacity of water treatment plants are often exceeded and a switch to alternative and less reliable water resources is needed. Wells are often polluted by flash floods (e.g. region Hancesti during 2010 flood).

The National Climate Change Adaptation Strategy (version of November 2012), several World Bank studies, information collected and discussions at the National Policy Dialogue meetings conducted in the course of implementing this project helped to identify main weather and water-related natural hazards to which Moldova and its WSS sector are most vulnerable. They are as follows:

- **Storms, windstorms and snow storms, torrential rain and hail:** according to World Bank estimations, Moldova is placed on the fifth place in the world among the countries which are most exposed to the risk of storms. In November 2000, a windstorm affected the livelihood of 2,600,000 people (more than 60% of total population) [3]. As interruptions in electricity supply to villages are amongst typical main damages produced by storms, especially in winter time when snow storms and rains sometimes result in heavy ice-loading on, and eventual breakages of, electricity grids, they threaten the reliability of water supply in villages using electric pumps for pumping water from deep boreholes – such "black outs" happened e.g. last December in some 150 villages, and in the whole northern Moldova in early 2000-ies. The problem is exacerbated by the fact that despite existing design and construction norms back-up power supply for WSS facilities (back-up power connection or generator) in rural areas is often absent;
- **Extreme summer and winter temperatures**: e.g. in summer 2012, an unfortunate combination of a prolonged *heat stress* (extreme temperatures) and a drought resulted in huge economic losses, mostly in agriculture, amounting to 1.25 billion USD[4] – equivalent of some 17% of country's 2011 GDP[5]. In WSS, extreme winter temperatures often damage water pipes placed on, or below but too near, the surface, as it is the case in some villages where water is supplied from local springs and streams. The problem is apparent even in Chisinau where some 30 km of distribution pipelines were frozen due to extreme temperatures in winter 2011/12;
- **Land slides:** The problem is exacerbated by the fact that connection of rural households to piped water supply and natural gas is not accompanied by connection to piped sewerage or septic tanks, to collect and dispose of wastewater safely;
- **Floods**: e.g. "2008 floods cost the country about 120 million USD". The most recent floods in 2010 had an adverse economic impact at some 0.15% of GDP [6]; and finally,
- **Droughts:** "drought is becoming endemic in many parts of the country and is increasingly affecting rural livelihoods and development". E.g. in 2007 and 2012 it "resulted in losses of up to 70% of major crops such as wheat, maize and sunflower" (NCCAS).

[3] Moldova - Storm, Rain and Frost, OCHA Situation Report No. 2, UN Office for the Coordination of Humanitarian Affairs, 2000

[4] World Bank, "Project Appraisal Document on a Proposed Credit to the Republic of Moldova for a Disaster and Climate Risk Management Project", July 6, 2010.

[5] Moldova's GDP: 7.003 billion USD, source: www.imf.org

[6] Post disaster Needs Assessment, Floods 2010, Gov. Republic of Moldova with support from EU, UN, World Bank

Vulnerability of Moldova and its WSS sector to droughts is very high indeed. According to a World Bank study, the 2007 drought affected a rural population of about 1.2 million persons in Moldova. 156 villages (some 300,000 people) were qualified as strongly affected, out of which 41 villages with 100,000 populations were the most affected by the 2007 drought. In such villages, the main or the only available source of water was shallow wells. In many cases, the source of water completely dried up[7]. A programme to help selected most affected villages was designed in 2008 but has not been yet implemented in the field. Unlike 2007, the consequences of the severe 2012 drought on rural WSS have not yet been properly assessed.

As rural population (whose income depends mostly on agriculture) accounts for some 60% of Moldova's total population[8], **indirectly**, the aforesaid huge losses in agriculture during 2012 drought may have a strong negative impact on the ability of rural population to pay for water and sanitation, thus exacerbating the affordability problem highlighted in section 5.7 of the revised WSS Strategy (October 2012), in which it is stressed that many households in Moldova already have to pay WSS bills exceeding the internationally recognised affordability limit of 5% of their disposable income.

Climate modelling and projections suggests that climate change will only increase the risk of the aforesaid weather/climate and water-related hazards in Moldova. Such impacts and the vulnerability of Moldova's WSS sector to them necessitate a policy response to adapt the water supply and sanitation sector to climate change. Adaptation measures proposed in this report are specifically intended to increase the resilience of WSS infrastructure to floods, droughts, and extreme weather events. They follow the approach designed by the OECD (2013, forthcoming):

- Know the risks for water resources and WSS, associated with climate change;
- Cap these risks, i.e. assess an acceptable level of risks, based on economic and social values;
- Manage these risks. Inter alia, this can include risk mitigation and risk sharing.

This report confirms that this approach is compatible with the objectives of the revised WSS Sector Strategy (2012-2027) and with the draft National Adaptation Strategy. Indeed, there are some redundancies between the different reference documents, confirming that they can be mutually reinforcing.

Finally, chapter 1 provides specific recommendations on how to best integrate proposed main adaptation measures for WSS into the revised Moldova's WSS sector strategy and other relevant policies, strategies and multi-year plans.

The objective of the **second chapter** is to provide a broad-brush estimate of the costs of the adaptation measures suggested in Chapter 1. This estimate focuses on additional measures, which are essential from an adaptation perspective, and which are not covered in the revised WSS Sector Strategy (or are not considered as priorities in the Strategy). The estimated amount may not be comprehensive but suggests an order of magnitude.

[7] Drought Emergency Project, Rural Water Component Moldova 2007, World Bank 2007

[8] National Workshop on Implementing a National Disaster Observatory (NDO) and Systematic Inventory and Evaluation for Risk Assessment (SIERA) in Moldova, 2010, GRIP, UNDP, CPESS

Additional capital costs to protect vulnerable villages from drought (not considered in the WSS sector strategy) amount to some 3.8 million EUR in total. Accelerated implementation of sanitation in the most vulnerable rural areas is expected to cost about 6.45 million EUR.

Basin planning is expected to cost 650,000 EUR and a water demand management plan another 400,000 EUR. Inventories and identification studies are expected to cost 900,000 EUR and a national plan for natural hazards (other than floods) another 200,000 EUR. All of these expenditures should take place over the 2013-2015 period. Inventories and identification studies are needed in particular to provide input into master planning and project development in order that projects that make the most efficient use of resources are financed as priorities. These studies should be used to identify efficiency gains that can be realised in water production and supply. Jointly with water demand management and other institutional measures, they will help reduce both the O&M costs and the need for construction of new infrastructure in Moldova - this approach concurs with the overarching principles of European Union water policy.

Priority institutional measures are assumed to be compliant with those undertaken as part of the Technical assistance for the Water SPSP in Moldova as part of the ongoing revision of the WSS Sector Strategy and thus do not involve incremental expenditures. Master plans and feasibility studies are also included in the revised WSS Sector Strategy and their costs are not included in this document in order to avoid double-counting. In summary, the revised WSS Sector Strategy estimates that 705 million EUR is required to meet long-term water supply and sanitation targets. As detailed in this strategy, such costs are deemed financially viable. Given that the incremental costs of climate change adaptation is below 2% of the investment needs in the WSS Sector Strategy, climate change adaptation in the WSS sector is also deemed financially viable.

The **third chapter** provides some indication on how such costs could be covered. The analysis confirms that the additional costs of adaptation are compatible with the order of magnitude of water-related expenditures in Moldova. Indeed, the adaptation measures proposed in this document essentially rely on low costs actions, or actions that do not generate additional expenditures for the government. Obviously, taking account of the overlap between the proposed adaptation strategy and the WSS Sector Strategy, adapting water services and infrastructures to climate change will depend foremost on the capacity of Moldovan authorities to implement the WSS Sector Strategy.

WSS sector spending is currently around 30 million EUR per year, of which two-thirds come from donors. Estimates of sectoral investments needs up to 2027, on the other hand, range from 705 million EUR (draft revised WSS Sector Strategy) up to over 3 billion EUR (full compliance with EU wastewater directives, based on tertiary treatment even in small agglomerations). The current level of sectoral financing is less than 1% of the GDP of Moldova; direct financing of WSS sector investments from domestic sources (public spending in Moldova) and foreign sources (donors and bilateral aid) has ranged from a low of 0.4% of Moldovan GDP (of which, 0.11% from national sources) in 2008 to a high of 0.7% of Moldovan GDP (of which, 0.23% from national sources) in 2010. The draft revised WSS Sector Strategy suggests that this level will have to increase to slightly above 1% of GDP for the entire planning period (up to 2027).

The chapter explores adaptation-specific financing measures. The experience of OECD countries in this domain is rather scarce. It deserves further attention to check if and how it could be adjusted to Moldovan context.

Introduction

The present document was prepared as a part of the project *"IMPROVING THE ENVIRONMENTAL QUALITY OF THE BLACK SEA THROUGH BETTER WASTE WATER TREATMENT & CLIMATE CHANGE ADAPTATION OF THE WATER SECTOR IN MOLDOVA"*. The project is sponsored by EC (DG ENV) and OECD/EAP Task Force and implemented by a consortium led by Kommunalkredit Public Consulting in the framework of the European Union Water Initiative (EUWI). The project comprises three tasks. The tasks are implemented through a National Policy Dialogue on water policy with senior policy-makers in Moldova. A summary of cross-fertilisation and synergies with other relevant activities and projects is presented in Annex D.

This report concludes Task 2: "Analyse selected adaptation measures and propose a feasible adaptation strategy for WSS". The need for developing a feasible adaptation strategy was identified under the previous OECD EAP Task Force project on developing a realistic mid-term Action and Investment plan for WSS in Moldova. The Adaptation Strategy for WSS is not intended as a standalone document, but a document that can be integrated into the following two policy documents:

- the National Climate Change Adaptation Strategy (NCCAS) to be adopted by the Government of Moldova; and
- the Moldova's WSS Sector Strategy which is under revision in the frame of the EC-funded Technical assistance for Water SPSP.

The objective of this task is to further analyse selected adaptation measures from the reference scenario developed in the report "Assessing the Impacts of Climate Change on Water Resources and WSS Systems in Moldova and Inventory Possible Adaptation Measures" (Task 1 Report) and propose a financially sustainable adaptation strategy for the water supply and sanitation sector.

Chapter 1 sketches a WSS sector adaptation strategy, adjusting the preliminary list of possible measures developed in Task 1 to the Moldovan context, and, due to affordability constraints, focusing on priority – low cost and "no regret" - adaptation measures. It analyses the compatibility of this strategy with related policy frameworks in Moldova. The recommendations are consistent with other efforts: to develop master plans, investment plans, water resource management plans, and feasibility studies for the WSS sector; they provide input to the development of a National plan for flood management (to be drafted with support from EIB *et al.*) and a national plan for reducing risks of other natural hazards (e.g. droughts).

Chapter 2 assesses the additional costs of this strategy. It compares them with available sources of finance for water policies in Moldova, and concludes that the proposed adaptation strategy is in line with these resources. The aforementioned strategic and planning documents and procedures are still under development (revision of WSS Sector Strategy, drafting master plans, etc.). Therefore, the present document offers a preliminary estimate of the incremental capital and other costs needed to implement WSS sector-specific climate change adaptation measures. These costs should be seen as additions to the capital costs of implementing the Moldova's WSS Sector Strategy.

Chapter 3 explores possible sources of finance for climate change adaptation measures in WSS, building on the scarce experience of OECD countries on this issue. It discusses the role of economic instruments as "well-designed instruments can improve the efficiency and timeliness of adaptation responses… They can also provide flexibility to deal with increase variability, risks and uncertainty" (OECD, 2013). The report concludes that the proposed adaptation strategy is financially viable.

1. A WSS sector Adaptation Strategy for Moldova

Task 1 report documents the projected impacts of climate change on water services and water infrastructures in Moldova. It inventoried a list of possible adaptation measures to be considered. This chapter builds on this analysis and adjusts the preliminary list of adaptation measures, taking the features of the Moldovan context into account. It checks the compatibility, and indeed the redundancy of the proposed measures with other policy frameworks in Moldova, namely the revised WSS Sector Strategy and the National Climate Change Adaptation Strategy. The analysis confirms that these policy frameworks are compatible and indeed, mutually supportive.

1.1 Conclusions from "Assessing the Impacts of Climate Change"

The Task 1 Report explored several key areas affecting the vulnerability of the WSS sector in Moldova to climate change, including:

- **Precipitation** – while overall precipitation is expected to remain close to past figures, the variability of this precipitation over the year is expected to increase dramatically, contributing to floods and droughts.
- **Surface water quantity** – climate change models conclude average run-offs of the surface water, including the rivers Prut and Dniester, will decrease by 2020 on average by 13% or even 16 – 20%[9] (depending on the modelling scenarios), while peak flows will increase, thus increasing the risks of floods and droughts.
- **Decreasing annual surface water runoffs and reduced ground water recharge** combined with the ambitious target of national economic development will lead to water scarcity in the 2020s or in the 2030s (when considering both surface and ground water) [10]
- **Surface water quality** – during droughts, surface water quality is expected to decline (involving decreased concentrations of dissolved oxygen and increased concentrations of N-ammonium, etc.). During floods, the concentrations of suspended solids and sediments are expected to increase.
- **Shallow water** –some 50% of the population of Moldova use shallow wells as a main source of water supply. During droughts – for example, as seen in 2007 and 2012 – the water tables lower and many shallow wells dry out, threatening the security of water supply in affected villages.
- **WSS sector infrastructure** – during floods, affected pumping stations stop operating and water mains can be damaged, capacity of water treatment plants are often exceeded and a switch to alternative and less reliable water resources is needed. Wells are often polluted by flash floods (e.g. region Hancesti during 2010 flood).

The National Climate Change Adaptation Strategy (version of November 2012), several World Bank studies, information collected and discussions at the National Policy Dialogue meetings conducted in the course of implementing this project helped to identify main weather and water-related natural hazards to which Moldova and its WSS sector are most vulnerable. They are as follows:

- **Storms, windstorms and snow storms, torrential rain and hail:** according to World Bank estimations, Moldova is placed on the fifth place in the world among the countries which are

[9] National Human Development Report. Climate Change in Moldova, 2009/2010

[10] ibid

most exposed to the risk of storms. In November 2000, a windstorm affected the livelihood of 2,600,000 people (more than 60% of total population) [11]. As interruptions in electricity supply to villages are amongst typical main damages produced by storms, especially in winter time when snow storms and rains sometimes result in heavy ice-loading on, and eventual breakages of, electricity grids, they threaten the reliability of water supply in villages using electric pumps for pumping water from deep boreholes – e.g. such "black outs" happened e.g. last December in some 150 villages, and in the whole northern Moldova in early 2000s. The problem is exacerbated by the fact that despite existing design and construction norms back-up power supply for WSS facilities (back-up power connection or generator) in rural areas is often absent;

- **Extreme summer and winter temperatures**: e.g. in summer 2012, an unfortunate combination of a prolonged *heat stress* (extreme temperatures) and a drought resulted in huge economic losses, mostly in agriculture, amounting to 1.25 billion USD[12] – equivalent of some 17% of country's 2011 GDP [13]. In WSS, extreme winter temperatures often damage water pipes placed on, or below but too near, the surface, as it is the case in some villages where water is supplied from local springs and streams. The problem is apparent even in Chisinau where some 30 km of distribution pipelines were frozen due to extreme temperatures in winter 2011/12;
- **Land slides:** due to this disaster, each year Moldova is loosing several dozens of rural houses. The problem is exacerbated by the fact that connection of rural households to piper water supply and natural gas is not accompanied by connection to piped sewerage or septic tanks, to collect and dispose of wastewater safely;
- **Floods**: e.g. "2008 floods cost the country about 120 million USD". The most recent floods in 2010 had an adverse economic impact at some 0.15% of GDP[14]. High vulnerability of Moldova to floods was recognised by stakeholders and a National plan for flood management soon will be drafted and then implemented with support from donors (EIB *et al*); and finally,
- **Droughts:** "drought is becoming endemic in many parts of the country and is increasingly affecting rural livelihoods and development". E.g. in 2007 and 2012 it "resulted in losses of up to **70%** of major crops such as wheat, maize and sunflower" (NCCAS).

Vulnerability of Moldova and its WSS sector to droughts is very high indeed. According to a World Bank study, the 2007 drought affected a rural population of about 1.2 million persons in Moldova. 156 villages (some 300,000 people) were qualified as strongly affected, out of which 41 villages with 100,000 populations were the most affected by the 2007 drought. In such villages, the main or the only available source of water was shallow wells. In many cases, the source of water completely dried up[15]. A programme to help selected most affected villages was designed in 2008 but has not been yet implementation in the field. Unlike 2007, the consequences of the severe 2012 drought on rural WSS have not yet been properly assessed.

[11] Moldova - Storm, Rain and Frost, OCHA Situation Report No. 2, UN Office for the Coordination of Humanitarian Affairs, 2000

[12] World Bank, "Project Appraisal Document on a Proposed Credit to the Republic of Moldova for a Disaster and Climate Risk Management Project", July 6, 2010.

[13] Moldova's GDP: 7.003 billion USD, source: www.imf.org

[14] Post disaster Needs Assessment, Floods 2010, Gov. Republic of Moldova with support from EU, UN, World Bank

[15] Drought Emergency Project, Rural Water Component Moldova 2007, World Bank 2007

As rural population (whose income depends mostly on agriculture) accounts for some 60% of Moldova's total population[16], indirectly, the aforesaid huge losses in agriculture during 2012 drought may have a strong negative impact on the ability of rural population to pay for water and sanitation, thus exacerbating the affordability problem highlighted in section 5.7 of the revised WSS Strategy (version of October 2012), in which it is stressed that many households in Moldova already have to pay WSS bills exceeding the internationally recognised affordability limit of 5% of their disposable income.

According to the Task 1 report, climate change in Moldova will be expressed more in high variability of run-off and in higher risk of extreme weather events than in dramatic changes in precipitation. In other words, the cycles of flood and drought are expected to continue and intensify.

Such impacts and the vulnerability of Moldova's WSS sector to them necessitate a policy response to adapt the water supply and sanitation sector to climate change. The overall conclusion from the Task 1 report is that business as usual is not an option for Moldova. This is because – regardless the true causes of the frequent weather and water related natural hazards observed in Moldova over recent decades, whether it is natural climate variability or climate change *per se* – their impacts on water resources and WSS, as well as social and economic consequences are very high and cannot be tolerated. Climate projections suggest that the risk of the weather and water-related hazards will further increase in the future, due to climate change, with greater impact on water resources and the WSS sector. To that end, a policy response is needed.

Remaining uncertainties regarding the timing and scale of impacts, however, are forcing decision-makers to focus on "no regret" measures (those that will bring multiple socio-economic and environmental benefits, including higher resilience to climate change), starting from low-cost ones[17]. For Moldova this focus is especially topical, taking into account fiscal and affordability constraints.

To that end, the Task 1 report proposed a preliminary list of possible adaptation measures to address the impact of climate change on water resources, water and sanitation infrastructure and the services provided to consumers. These measures included those that can directly be implemented in the WSS sector and improve the quality of water resources, protect existing water and sanitation infrastructure from climate change impact and other stressors, upgrade existing infrastructure to meet future challenges or improve the WSS planning (regional/river basin planning). The list of measures also includes those that have an indirect positive impact on the WSS sector's resilience to the aforesaid natural hazards, the probability of which will grow due to climate change, e.g. general risk assessment and management, or urban planning.

Climate change is only one among several drivers impacting WSS and should be seen as interconnected with other major drivers. Therefore, the measures should not be understood as exclusively addressing climate change impact: in fact, many of them would bring multiple benefits. Further, some of the proposed measures (e.g. on general flood prevention infrastructure) will have a trans-boundary impact and would need to be coordinated with neighbouring countries, i.e. Romania and Ukraine. In November 2012, Moldova and Ukraine signed an agreement of

[16] National Workshop on Implementing a National Disaster Observatory (NDO) and Systematic Inventory and Evaluation for Risk Assessment (SIERA) in Moldova, 2010, GRIP, UNDP, CPESS

[17] By minimal costs here we mean minimal annualised capital and O&M costs.

cooperation on the management of the Dniester river; this provides the appropriate setting for such coordination.

1.2 Proposed WSS sector Climate Change Adaptation Strategy for Moldova

The objectives presented in this section provide a reference according to which the implementation of a climate change adaptation strategy for the WSS sector could be measured and evaluated. As an **overall objective**, the current document serves as recommendations on priority adaptation measures for inclusion in the revised WSS Sector Strategy and the National Climate Change Adaptation Strategy.

The specific objectives of the initial WSS Sector Adaptation Strategy correspond to the high level/priority adaptation measures set out in the Task 1 report. The report confirms that, in general, improved access to water supply and sanitation services contributes to effective adaptation. More specific measures were identified in the areas of:

- protecting existing water and sanitation infrastructure from climate change impact and other stressors. Relevant options include protection of water intakes from increased flows; installation of state of the art treatment facilities, adapted to poor quality water;
- upgrading existing infrastructure to meet future challenges and cope with the risks associated with climate change (e.g. aeration facilities for ammonium oxidation; pre-sedimentation ponds or river bank filters; shifting from shallow wells to more reliable sources of water supply, such as surface water and confined aquifers; small scale, sustainable solutions for sanitation in rural areas). Recent experience in Moldova confirms that, when properly designed and operated, basic treatment plants can deliver under extreme weather conditions;
- managing water demand, with particular emphases on mechanisms that can adjust water demand to availability (such as pricing complemented by sound metering, and flexible water abstraction limits: one for normal and another for emergency situations) and on the use of alternative water sources (rainwater; reclaimed water, when it is fit for use);
- improving WSS planning (Master plans and mid-term investment plans), including an inventory of groundwater resources and their relevance for water supply; emergency plans with clear instructions on what to do and when. Zoning and setting priority areas are important components of cost-effective adaptation in Moldova.

In addition, the Task 1 report noted that other adaptation measures can have an indirect positive impact on WSS: implementation of IWRM, general risk assessment and management, urban and land use planning, general flood management, the promotion of water retention measures and reduction of run-offs (in particular with green infrastructures, as they can be low-cost and scalable to risks). For instance, land-use planning and related regulations should discourage people to settle in flood plains, and fixed assets from being built in these areas. Building and construction codes should make sure that should equipment is built, they take account of potential floods.

These objectives are consistent with the draft revised Moldova's WSS Sector Strategy: essentially all of the measures support, or are supported in, the WSS Sector Strategy. This also means that by accomplishing the objectives laid out in this report and in the draft revised WSS Sector Strategy, the Government of Moldova will contribute to the objectives set out in the National Climate Change Adaptation Strategy.

The objectives and measures proposed in Task 1 report address the risk of climate change and the vulnerabilities to climate change of water sources, WSS infrastructure and population in the Republic of Moldova.

Adaptation measures envisaged in this report are specifically intended to increase the resilience of WSS infrastructure to floods, droughts, and extreme weather events. While adaptation measures are usually tailored to specific locations and circumstances and cannot be transferred directly from other countries, international experience can be considered to identify climate change adaptation measures for Moldova's WSS sector. Given the condition of the WSS infrastructure and its vulnerabilities to climate change, some of these measures are deemed appropriate for Moldova.

However, an appropriate package (mix) of adaptation measures for WSS in Moldova should best address all the key risks and impacts to which the country is most vulnerable. Based on these considerations, the main measures to be considered to adapt water services and water infrastructures to climate change in Moldova were developed using a risk-based perspective developed by OECD and discussed in a recent paper[18].

According to this approach, the role of the Government of Moldova is to “know”, “cap” and “manage” water risks. To this end, the sector specific adaptation measures identified for Moldova are categorised into knowing, capping, and managing risks to water resources. Additional details of this method, as well as a table showing the correspondence of these measures to those presented in the Task 1 Report, are provided in Annex A.

1.2.1 Know the risks

Measures to help “know” the risk are necessary to close information gaps and increase awareness in the government and the public of climate change impacts and the risks they entail. Proposed measures are:

- Improve hydro-meteorological monitoring system to obtain timely and reliable data for the assessment and management of main risks of weather and water-related disasters
- Develop disaster and climate risk assessment system, as a basis for urban and infrastructure planning, especially in most vulnerable areas
- Upgrade existing disaster management structures (e.g. the Civil Protection and Emergency Situations Service, CPEES) or set up a national center (and eventually local centres in Prut and Dniester basins) for weather and water related disasters preparedness, risk assessment, and management, in coordination with Ukraine and Romania, as appropriate.
- Conduct inventories of current conditions of water and sanitation infrastructure in order to inform decisions on how best to cap and manage risks to WSS of climate change and guide investment decisions.

Inventories are necessary, as Moldova lacks data needed for risk assessment and management.

1.2.2 Cap the risks

“Capping the risk” calls for determining the acceptability and tolerability of given risks associated with climate change. It is about making a political decision (through democratic procedures) on the acceptable levels of risks, while the implementation of the decision made falls under the “manage

[18] Water and Climate Change Adaptation: Policies to Navigate Uncharted Waters, OECD, 2013 (forthcoming).

the risk" category. The political decision should rely on both evidence- and values-based judgements. The Government of Moldova (GoM) should engage key stakeholders in decision-making. To this end, the measures identified in this group are as follows:

- Raise public awareness for water conservation and water protection behaviour
- Inform populations about water-related risks and the potential impacts of climate change
- Assess the level of security people are willing to reach; inform them about the costs and constraints associated with alternative levels of security

1.2.3 Manage the risks

Measures aimed at "managing the risks" involve the need for the Government of Moldova to address institutional and regulatory barriers that may inhibit timely and efficient adaptation. Foremost, "no regrets" and "low regrets" options should be identified that are applicable in all plausible futures. To that end, the following measures are recommended:

- Develop and implement IWRM plans at basin level, while factoring in climate change. IWRM plans should provide an acceptable level of security (see above) at affordable costs. They include measures to decrease vulnerability (e.g. banning new settlements in flood prone areas, making the best use of alternative sources of water, see below).
- Develop and implement a country-wide flood management plan, including preventive measures; adjust land use planning, building and construction codes to discourage activities and construction in flood prone areas;
- Develop and implement a national plan to manage other climate related natural hazards (such as droughts, extreme heat and frost, strong winds, landslides, etc.)
- Improve water use efficiency – related activities should be part of respective sectoral programmes and water demand management plans, foremost in the irrigation and WSS sectors, as well as in water-intensive industries
- Improve and/or create flood warning systems in Prut and Dniester basins
- Coordinate hydro-meteorological monitoring, risk assessment and risk management activities in trans-boundary basins with neighbouring countries: Romania and Ukraine.

1.2.4 Make the best use of green infrastructures and alternative sources of water

- Create water retention areas, flood control reservoirs/natural retention polders in areas at risk of floods
- Increase soil infiltration using wetlands, afforestation; avoid sealed surfaces in urban development
- Maintain natural flood plains for rivers where appropriate
- Combine artificial groundwater recharge, wastewater re-use, rainwater harvesting, where possible and feasible.

1.2.5 Fix and adapt conventional water infrastructures

- Protect most vulnerable villages fully dependant on shallow wells from drought by shifting to more reliable sources of water (surface water or deep boreholes/confined aquifers)

- Improve wastewater infrastructure capacity - focus on low-cost options in rural areas (e.g. septic tanks and EcoSan toilets), while suburban areas of big cities could be connected to centralised sewerage systems operated by *apacanals* (urban water utilities)
- Adapt the design of dikes and dams for flood protection; rehabilitate existing and build needed additional dikes and dams where other options (e.g. green infrastructure) cannot be applied; this should be part of the future national plan for flood management
- Improve the operation and maintenance of existing flood management facilities (dikes, dams)
- Build intercepting collector drainage downhill of villages in landslide-prone areas
- Consider rehabilitation of existing and building new sewerage systems for collecting and safe disposal of storm waters in cities, to reduce the risk of flash flooding during torrential rains
- Protect existing and properly functioning water supply and wastewater facilities against flooding and direct impacts of increased river flows (water intake facilities, pumping stations/treatment plants)
- Upgrade the performance of existing water treatment plants and wastewater collection and treatment infrastructure in Moldova (e.g., installation of pre-sedimentation pond or river bank filters for pre-treatment; aeration facilities for ammonium oxidation).

1.2.6 Make the best use of economic instruments and other regulatory instruments

- Put in place tariff systems complemented by appropriate metering that can curb water demand, taking into account affordability constraints
- Set sustainable water abstraction limits for both regular and water-stressed periods
- Define water rights in a flexible way: e.g. by adopting two sets of water allocation rules: one for normal and another for emergency situations - this can ensure that priority uses are served is case of scarcity
- Consider flood insurance schemes – e.g. obligatory insurance of immovable property in flood and landslide-prone areas – this provides a disincentive to build in such areas and takes some of the burden of the insurer of last resort from the public purse

These strategic adaptation measures are fully consistent with the objectives of the revised WSS Sector Strategy, as well as with the aforesaid overarching objective set out in the NCCAS.

These measures are further assessed in Annex A to this report.

The discussion below highlights the compatibility (and indeed the redundancies) between the measures suggested in this document and the revised WSS Sector Strategy and the National Climate Change Adaptation Strategy. These redundancies confirm that these policy frameworks can be mutually supportive.

1.3 Mainstreaming adaptation strategy in related national strategies and plans

1.3.1 Key objectives of the National Climate Change Adaptation Strategy

The National Climate Change Adaptation Strategy (NCCAS) of the Republic of Moldova (revised Final version dated November 2012) has the following general objective:

"To ensure that the Republic of Moldova's social and economic development is resilient to the impacts of climate change, by establishing a strong enabling environment and clear direction for an effective and coherent climate change adaptation process to take place across all relevant sectors."

To support the general objective, the Strategy defines three specific objectives, as follows:

- **Objective 1: Improve the management and dissemination of disaster and climate risk information in Moldova**. The Strategy sees knowledge of climate hazards and impacts as the starting point for promoting climate resilience.
- **Objective 2: Ensure that climate change adaptation is a national and local priority with a strong institutional basis**. The Strategy holds that a strong policy, legislative and institutional framework for climate risk management is required to support capacity to implement specific sectoral measures in Moldova, based on a sound understanding of the risk (Objective 1). A strong institutional basis will create the platform for capacity development and strengthened inter-sectoral coordination, as well as eliminate barriers to innovation and effective action on adaptation.
- **Objective 3: Build climate resilience through reducing risk and facilitating adaptation in priority sectors.** The Water sector is considered as one of the priority sectors, in the Strategy. The Strategy states that climate resilience can be achieved not only by introducing specific adaptation activities, but also through a thorough review of existing and planned activities that can integrate climate risk in order to avoid mal-adaptation and ensure that planned investment is as cost effective as possible.

The Strategy also specifies a number of activities to be carried out within each objective.

The main adaptation measures for WSS proposed above in section 1.2 – foremost those under headings Know the risk, Cap the risk and Manage the risk - are fully compatible with the three objectives of the NCCAS.

1.3.2 Integration of the Proposed Strategic Adaptation Measures into the Revised WSS Sector Strategy

A revised WSS Sector Strategy for Moldova (2nd draft dated October 2012) has been drafted with support from the EC-funded TA Water SPSP. The revised WSS Sector Strategy includes statements of vision, mission, values, and objectives to be achieved up to 2017. Broadly speaking, the vision, mission, and values focus on increasing access of the population to safe water supply and adequate sanitation with an emphasis on ensuring quality and promoting efficiency. The revised WSS Sector Strategy also sets out medium-term and long-term objectives to be achieved during the period 2012-2017 and 2017 to 2027, respectively.

Medium-term objectives are focused on the legal and planning framework for WSS services, promotion of market economy principles, promotion of efficient and cost-covering WSS services, and promotion of social partnership by increasing public participation in planning.

The long-term objectives are focused, among others, on compliance with EU directives, meeting Millennium Development Goals in terms of access to safe water supply and sanitation, and public consultation and access to information.

Further, the revised WSS Strategy sets out medium and long-term investment objectives for the WSS sector. For water supply, the medium-term investment objective is to focus on the rehabilitation of water catchments structure, water treatment plants, pumping station and networks,

extension of the existing drinking water distribution network. The medium-term investment objective for sanitation is to focus on the rehabilitation/upgrading of wastewater treatment plants and sewerage network extension. The medium-term investment target is to achieve coverage in WSS infrastructure of 30% of the unconnected population in urban areas and 20-25% in rural areas. The long-term investment objectives for water supply and sanitation are to achieve long-term sustainability, improve environmental sustainability, comply with the National Development Strategy, regional strategy objectives and the relevant European Union (EU) Directives.

Finally, the revised WSS Sector Strategy provides an indicative list of water supply and sanitation infrastructure that should be completed by the two target years of 2017 and 2027.

It is evident, that the main adaptation measures for WSS proposed in section 1.2 are also compatible with the foregoing objectives of the revised WSS Sector Strategy.

However, the proposed main adaptation measures for WSS need to be properly integrated into the revised WSS Sector Strategy and other relevant policies, strategies and multi-year plans, and the following section contains specific proposals on how that could be achieved.

Draft revised WSS Sector Strategy (the version dated October 2012) contains a **section on climate change threats** (section 4.3.4). This section correctly stresses that "*water resources in the Republic of Moldova are sensitive to climate change both from the point of view of quantity and quality*", and concludes that "*the safety of water supply for all users will be jeopardized*" (by impacts of climate change).

However, the section has a number of weaknesses: e.g. out of all impacts of climate change on water resources and WSS infrastructure in Moldova, it discusses only water deficit, not touching floods and other hazards to which water resources and Moldova's WSS are vulnerable (see Task 1 report and section 1.1 above).

A fundamental weakness of the section on climate change threats in the draft revised WSS Sector Strategy is its purely descriptive nature: it describes the problem (only partially though), but does not propose measures to address the identified significant risks to the safety of water supply, nor does it propose/envisage actions to make WSS more resilient to climate change and climate-related risks and hazards.

Adaptation measures are not considered in the mid-term Action Plan for implementing the strategy either (Annex 12 to the draft revised WSS Sector Strategy).

Obviously, these and other main weaknesses of the draft revised WSS Sector Strategy with respect to climate change adaptation need to be addressed before the document (revised Moldova's WSS Sector Strategy) is submitted to the Government of Moldova for official consideration and eventual approval.

The team working on this project has developed two specific recommendations in this regard, namely:

- recommendations on adjusting the mid-term Action plan for implementing the sector strategy (see Annex B to this report)
- recommended text of section 4.3.4 in draft revised WSS Sector Strategy (see Annex C to this report).

These recommendations were sent for consideration to the Ministry of Environment as well as to the team leader of the EC-funded TA Water SPSP. Authors of this report strongly believe that

implementing these recommendations would help improve the climate change adaptation dimension of the revised Moldova's WSS Sector.

1.3.3 Integration of the Proposed Strategic Adaptation Measures into Other Relevant Policies, Strategies and Plans

Creating a favourable framework for the integration

Initial version of the NCCAS of Moldova (the draft Final version dated November 2012) envisaged the following activity:

"Activity 2.4: Create a mechanism for integrating climate risk into all future policies"

The project team working on this project, in its comments on the (draft Final) NCCAS inter alia has recommended that climate risks and appropriate adaptation measures should be integrated not only in all future (new) policies, as well as strategies and multi-year plans, but (gradually) also in all existing ones, e.g. during the process of their revision, as it was the case with the revision of Moldova's WSS Sector Strategy.

The Working group responsible for preparing NCCAS for submission to the Government of Moldova - for official consideration and eventual approval, - took the recommendation on board, by proposing in the revised version of NCCAS the following:

"Activity 2.4: Create a mechanism for integrating climate risk into existing and future policies

- Create a mandate that all existing policy revision / creation of new policies, are put through a climate screening process.
- Establish a climate screening framework, whereby each key objective/activity proposed under new/amended policies and plans are assessed for the potential impact of climate change on their outcome.
- Initiate a process to amend/modify/revise these activities/objectives as appropriate."

These provisions in the NCCAS will create favourable conditions for integrating climate risk and respective adaptation measures into sectoral policies and strategies, including the revised WSS sector strategy, a mid-term Action plan for implementing the strategy; and the future National plan for flood management.

Integrating proposed main adaptation measures into other relevant policies, strategies and multi-year plans

They include, but are not limited to, the following key policies and plans:

- government policy for agriculture, as it affects both quantity (irrigated agriculture is a main water consumer in Moldova) and quality (e.g. through diffuse pollution of water resources by agriculture) of water available for WSS;
- future Master plans for WSS envisaged by the revised WSS Sector Strategy (this undertaking is fully supported also by this report);
- future National plan for flood management, to be developed with support from EIB and others; and, finally;
- future national plan for managing other risks of natural hazards, to be developed with support from donors.

It is premature to formulate specific recommendations on how the main adaptation measures proposed in this document could be best integrated in these future multi-year plans. However, some measures fitting into other plans are highlighted in section 1.2.

2. Costing water adaptation measures in Moldova

As noted in the Task 1 report, adapting to climate change will add to the already substantial financing gap for water systems in Moldova. It also raises several specific challenges for financing, due to problems of attribution, long-time frames and pervasive uncertainty. Mainstreaming climate change adaptation into water policies, programmes/multi-year plans and projects so that to achieve overall water policy objectives at least cost, is a challenging task. This can frustrate efforts to identify the "incremental" cost of adaptation. Nevertheless, efforts to account for adaptation funding and to demonstrate value for money should not inadvertently undermine mainstreaming.

Overall, financing adaptation should build on sound approaches to financing water systems generally and avoid skewing financing to "speciality" projects that might be easily labelled as adaptation but do not necessarily maximise net benefits.

The examples above illustrate the challenge of avoiding double counting when estimating incremental costs of adaptation measures for WSS.

Nonetheless, required incremental capital investments that are specific to WSS sector climate change adaptation need to be specified and valued; at a minimum, the most urgent/priority adaptation measures need to be assessed. This section tries to assess such costs, based on recent experience in the country and local unit costs for investments (such as in EcoSan toilets). It cannot be comprehensive, but signals orders of magnitude.

2.1 Identifying additional costs of "soft" measures

As the discussion above made clear, costing the adaptation strategy should avoid double counting expenditures already covered by other policy documents (in particular, the revised Moldova's WSS sector strategy and the National Climate Change Adaptation Strategy).

The measures categorised under "Know the risks" essentially are inventories and soft measures related to collection of information and data. Hydro-metrological monitoring, disaster and climate-risk assessment systems, and upgrading of disaster management structures will benefit the WSS sector, but should be undertaken regardless of WSS section adaptation.

The mid-term Action Plan for the revised WSS Strategy does not contain measures to implement or improve disaster risk management. The NCCAS, on the other hand, under its Activity 1.1 "Build capacities for gathering, analyzing and disseminating climate risk information" and Activity 1.3: "Establish a regional coordination body with Ukraine and Romania to link activities on disaster and climate risk management" indicate a similar focus as the present document.

Inventories, on the other hand, are specific to this document and while necessary for the development of the WSS Sector as a whole, may be considered as incremental expenditures attributable to climate change adaptation of the WSS sector. **The incremental costs to conduct proposed inventories in the WSS sector are assumed at 900,000 EUR.**

Measures aiming at "capping the risks" typically do not generate high expenditures from the public budget. Raising public awareness will require some targeted communication campaign, but this is covered under the revised WSS Sector Strategy (though not reflected in the medium-term Action plan in the revised WSS Sector Strategy).

Measures related to "managing the risks" are more diverse. Some initiatives essentially are regulatory measures, which are neutral from a public finance perspective. They may generate

opportunity costs (e.g., the measure on preventing the development of flood prone areas), but the net effect on the economy and public budgets is assumed to be positive (this is the rationale for adaptation). Some may generate additional costs for private investors (e.g. property developers), and some accompanying/compensation measures may be required, but it is premature to cost them at this early stage.

Most of the measures related to adapting water infrastructure would require planning (e.g. basin plans, master plans for WSS, water demand management plans) and project preparation (i.e. feasibility studies). Developing national and river basin plans for water and flood management, as well as master plans for WSS infrastructure will require developing capacities.

It is assumed that capacity development measures regarding flood management will be included in the future National Plan for Flood Management and for this reason are not included in this analysis, to avoid double counting. **Therefore, additional costs should be considered only for basin plans: they are estimated at 650,000 EUR.**

The incremental costs of development of water demand management plans are assumed at 400,000 EUR. Additional costs of a national plan of management other natural hazards are assumed at 200,000 EUR.

Green infrastructures are supposed to be a cost-effective alternative to concrete and metal structures. If they are not considered in the implementation of the other policy frameworks, they are expected to save costs, especially from the public budget (if they do not generate savings, there is little benefit in considering them as a valuable option). Some compensation measures will be required (e.g. when clearing and/or re-establishing flood plains of rivers), but they should be less costly than alternatives made of concrete and metal. **A cost of 50,000 EUR is assumed for a feasibility study on rainwater harvesting, guidelines and incentives for its use.**

Regarding master planning and project development in WSS (feasibility studies for major and minor projects), the revised WSS Sector Strategy lists individual costs for master plans and feasibility studies (about 187 thousand EUR for regional master plans, 125 thousand EUR for feasibility studies for major projects, and 62,500 EUR for minor projects. Our experience in Moldova suggests that these unit costs look appropriate for the current capacities in Moldova; once domestic capacity is developed to prepare feasibility studies that comply with approved guidelines, the units costs should decrease). That is, these costs are already envisaged in the revised WSS Sector Strategy and therefore are not included in the incremental costs of adaptation.

Capacity development also is considered a priority: e.g. the development of guidelines is foreseen under the Technical assistance for Water SPSP that has developed Moldova's revised WSS Sector Strategy (as reflected in the Action plan, under action 2.3.3: WSS Infrastructure Development). Therefore, capacity development costs are not included either.

The use of appropriate Economic instruments are considered as mechanisms to lower the costs of adaptation, by creating respective incentives (e.g. for water conservation). Improving existing and introducing new regulatory instruments are considered as a routine responsibility of the government and our assumption is that this measure will not require additional financing.

Furthermore, the overall fiscal effect from such improvements might be positive, as they can generate revenues which contribute to financing adaptation measures (see section 3).

2.2 Costing adaptation of water services and water infrastructures to climate change

This section assesses several categories of expenditures considered as additional costs directly related to adapting WSS services and infrastructures to climate change. As only additional measures or costs are mentioned here, successful adaptation will rely on the implementation of other adaptation measures through other strategies and plans, foremost the revised Moldova's WSS Sector Strategy, the National Climate Change Adaptation Strategy and the future National plan for flood management.

Additional costs relate to capital investment in infrastructures which may not be considered a priority in the revised WSS Sector Strategy, but which are essential from the adaptation perspective. This is the case, for instance, of protecting vulnerable villages from drought risks. The WSS Sector Strategy and related Action plan do not address drought as a separate priority issue.

The urgent expenditures needed to address the vulnerability of the villages and rural areas most prone to drought are detailed in section 2.2.1 below.

The WSS Sector Strategy may cover the most vulnerable ones under standard conditions, whereas adaptation will require a broader approach, as climate change is expected to affect all villages presently fully dependant on shallow wells as the main source of drinking water.

The costing exercise below is based on these assumptions.

2.2.1 Additional capital costs

An area of incremental investment needs related to top priority adaptation measures is the number of persons that use shallow wells as the main source of water supply. While for a proportion of these persons, investments in improved water treatment and sanitation would be envisaged in the WSS Sector Strategy, evidence is mounting that a prompt response is already needed in villages where water supply is fully dependant on shallow wells that are exposed to drought.

As was already mentioned, according to a World Bank study, the 2007 drought affected a rural population of about 1.2 million persons. 156 villages in Moldova were qualified as severely impacted. In such villages, the main (and often the only) available source of water was shallow wells. In many cases, the source of water completely dried up[19].

Adaptation of the water supply and sanitation services to climate change in these villages in Moldova could involve a number of approaches, including:

- Resettlement of the population to areas where drought does not affect water supply (or where water supply is more resilient to drought)
- Aggressive investment to construct piped water supply systems using deep boreholes or surface water as the source of water supply and providing household connections
- Addressing only the villages in most urgent need of more resilient water supplies – out of the 156 villages, about 41 villages with 100,000 population were the most affected by the 2007 drought

The first approach is not estimated as it is assumed that the economic costs and general social upheaval would greatly outweigh the adaptation benefits.

[19] Drought Emergency Project, Rural Water Component Moldova 2007, World Bank 2007

The second approach generates total adaptation costs of about 186 million EUR, based on an assumed unit cost of 155 EUR per person connected. Given that most of these costs fall under the priority projects in the revised WSS Sector Strategy (2012-2027), the additional cost of adaptation is limited to the costs of protecting the villages most affected by drought.

The aforementioned World Bank study proposed to construct piped water supply system in the most affected villages where some 100,000 people live to deliver water to all households, as well as to all kindergartens and schools. Regarding water supply for households, these systems would take the form of a minimal number of street/stand posts in order to supply people with water sufficient for drinking, cooking and hygiene (some 20-50 lcd), but not for watering their properties or other water intensive activities.

The World Bank Study estimated the unit capital costs for that most urgent /top priority adaptation measure at about 38 EUR per person in the most affected villages. **This gives a total of 3.8 million EUR.**

Regarding sanitation, a priority adaptation measure, driven also by the need to reduce environmental and health risks by improving hygiene conditions, would be the implementation of such low-cost options as Ecosan toilets or – where reliable piped water supply is available – septic tanks in all kindergartens, schools and other public buildings in rural areas. Based on ApaSan project data, unit costs of building an Ecosan toilet is 11 EUR per user of a public toilet, and 250 EUR for an individual unit. The revised WSS Strategy assumes that 214 public and 296 individual Ecosan toilets (totalling 2354 EUR and 74,000 EUR, respectively) will be implemented by 2017, followed by a total of 610,088 individual units (152 million EUR) by the end of the planning period 2027. Thus, the necessary investments have been identified in the revised WSS Sector Strategy.

The figures for the needed public Ecosan units appear low, as in 2011 there were 1,080 pre-school institutions in rural areas of Moldova alone (of a total of 1,400 pre-school institutions) and 1,092 day-schools in rural areas (of a total of 1,457 day-schools overall in the country)[20].

Furthermore, in order to facilitate climate change adaptation, it is likely that these investments will need to be accelerated. Therefore, it is assumed that the incremental investment in rural sanitation that is attributable to climate change adaptation is on the level of 40% of rural pre-school and primary school institutions, assuming that each of these institutions requires two units. The cost is roughly 20,000 EUR. For individual units, in private dwellings, it is assumed to be about 25,000 units (corresponding to the needs of priority villages for intervention in water supply), totalling 6,250,000 EUR are urgent for installation and therefore considered to be incremental investments in rural sanitation attribute to climate change adaptation. **Thus, the total estimated incremental cost of adaptation in the sanitation sector is estimated at 6.45 million EUR.**

2.2.2 One-time costs of institutional measures

Significant institutional capacity needs to be developed in the Moldovan WSS sector to increase efficiency in the sector. This is adequately covered under the revised WSS Strategy, which includes a planning and programming unit for WSS investments at the Ministry of Environment, guidance documents for the establishment of regional operating companies, performance indicators for the WSS sector, development of water safety plans, and development of procedure for reporting, scoring and prioritising projects into a WSS Project Pipeline, etc.

[20] National Bureau of Statistics of the Republic of Moldova.

Since these activities are compatible with the needs of climate change adaptation in the WSS sector, it is assumed that no incremental expenditures are required in this area.

2.2.3 General adaptation and sector-specific planning

General and sector-specific planning activities are covered under other strategies and plans, in particular the revised WSS Sector Strategy. Integrated water resource planning, however, is assumed at a cost of 650,000 EUR, as indicated above.

2.2.4 Disaster and climate risk assessment and water retention measures

As detailed in section 2.1, disaster and climate risk assessment is assumed to encompass more than just the WSS sector and activities thereunder are expected to take place regardless of WSS adaptation. The costs of water retention measures must be estimated as a result of detailed studies and inventories of water resources and WSS assets. The costs of such studies are estimated under section 2.1.

2.2.5 Recurring costs

Feasibility studies and master plans are recurring costs. As detailed in section 2.1, however, these costs are considered in the revised WSS Sector Strategy and are thus not incremental costs of WSS sector adaptation.

2.2.6 Summary of adaptation costs and affordability thereof for the public budget and rural households

The total current estimate of incremental costs of the adaptation measures proposed in this report are shown in the following table.

Table 1Incremental costs of specific measures for climate change adaptation in the WSS sector

Category	Name of measure	Incremental cost (million EUR)	Recurrence	Timeframe
"Know the risks"	Inventories of water resources and WSS infrastructure	0.900	One-time	2013-2014
"Capping the risk"	Improve water use efficiency (water demand management plans)	0.400	One-time	2013-2014
"Managing the risks"	Integrated Water Resource Management Basin Plans National plan of managing other natural hazards	0.650 0.200	One-time	2013-2015
Green infrastructures	Study on rainwater harvesting, including incentives	0.050	One-time	2013
Urgent adaptation measures in water supply in 41 villages most affected by, and prone to, drought	Priority adaptation measures in 41 villages most affected by drought	3.800	Expenditures take place over 1-2 years	2013-2015
Urgent sanitation measures in areas most affect by and prone to drought	Ecosan toilets installed	6.450	Expenditures take place over 1-5 years	2013-2017

Category	Name of measure	Incremental cost (million EUR)	Recurrence	Timeframe
One-time costs of institutional measures	Adequately reflected in the revised WSS Strategy	n.a.		
General adaptation and sector-specific planning	Considered in section 2.1	--		
Disaster and climate risk assessment and water-retention measures	Disaster and climate risk assessment is assumed to encompass more than just the WSS sector and activities thereunder are expected to take place regardless of WSS adaptation. The costs of water retention measures must be estimated as a result of detailed studies and inventories of water resources and WSS assets.	--		
Recurring costs	Master plans and feasibility studies are recurring costs. As detailed in section 0, however, these costs are considered in the revised WSS Sector Strategy and are thus not incremental costs of WSS sector adaptation.	--		
TOTAL		**12.45**		

Thus, the estimate of incremental costs of the climate change adaptation measures proposed in this report is 12.45 million EUR, i.e. less than 2% of the WSS sector investment needs (705 million EUR) estimated in the draft revised WSS Sector Strategy (see section 3.2 below).

Note that adaptation measures in WSS contribute the most to this figure. As discussed above, this is because most of the recommended “soft” measures either are already covered in the revised WSS Sector Strategy, or will be covered in the future National plan for flood management, or will be implemented as part of the routine work of the government (thus no need for additional resources) – for more detail, see Annex A.

To avoid double counting, the costs of such measures were not included in the total incremental adaptation costs estimated in this section.

3. Financing water adaptation measures in Moldova

Beyond widening the financing gap, financing climate change adaptation raises several particular challenges for financing, due to problems of attribution, long time frames and pervasive uncertainty about future impacts. The problem of attribution arises from the fact that climate change adaptation typically occurs in the context of responding to a range of natural and socio-economic pressures on water systems. Adapting water systems better to deal with current (natural) climate variability also increases resilience to long-term climate change. Thus, identifying specific measures or actions that respond solely and exclusively to the impacts of long-term climate change is both difficult and often impracticable. Indeed, mainstreaming climate change adaptation into water policies, programmes and projects is important to ensure that responses address a range of stressors and achieve overall water policy objectives at least cost. However, mainstreaming can frustrate efforts to identify the 'incremental' cost of adaptation. Attempts to identify this 'incremental' cost are often driven by political imperatives motivating processes to account for how adaptation funding is spent. While it is clearly important to promote accountability in the disbursement of adaptation funding and to ensure value for money, efforts to label financing for adaptation should avoid impeding mainstreaming and distorting the allocation of financing to 'speciality' adaptation projects that may be easily labelled as 'adaptation' but do not necessarily maximise net benefits[21].

The long time frames and pervasive uncertainty associated with climate change also pose a challenge for financing. The expected cost of adaptation measures are usually known and incurred in the short term, while the expected benefits are more uncertain and accrue far into the future. This complicates the task of trying to determine an economically efficient level and timing of adaptation actions. Many water projects have very long asset lives (e.g. 80 – 100 years for dams), which means that taking climate change into account is essential to avoid costly mal-adaptation. Project financing, however, typically operates on a scale of 20 years or less, which may dull incentives for financiers (and also governments) to account for climate change impacts in the design of water projects[22].

This section inventories existing sources of finance for water services and water infrastructures in Moldova. Building on two recent reports, and trying to reconcile apparent discrepancies, it confirms that the additional costs of adaptation measures considered in this document are compatible with available finance for water-sector expenditures in Moldova. It discusses adaptation-specific sources of finance, which may be considered in the Moldovan context.

3.1 Overview of WSS sector financing (2008-2012)

In Moldova, capital investment in the WSS sector is financed by the Government, local funding sources and international funding programs. These funding sources refer to:

- Government State Budget allocations handled by the Ministry of Finance (MoF)
- National Ecologic Fund (NEF), which is part of the State Budget, but handled by the Ministry of Environment

[21] Water and Climate Change Adaptation: Policies to Navigate Uncharted Waters, OECD, 2013 (forthcoming).

[22] *Ibid*.

- National Fund for Regional Development (NFRD), which is part of the State Budget, but is managed by the Ministry of Construction and Regional Development
- Social Investment Fund (SIF)
- Administrative Territorial Units (ATU), or local budgets; every administrative territorial unit is entitled to plan and manage its own annual territorial budget
- External funds, which comprise various donor and creditor funds disbursed into Moldavian WSS infrastructure directly or through public institutions or special Government funds.

Two recent documents address the issue of spending for WSS in Moldova: an Action and Investment Plan developed by the OECD[23] and the revision of the WSS Strategy for Moldova[24]. Taking into account the fact that different funding sources, such as the National Ecological Fund (NEF), the National Fund for Regional Development (NFRD), and the Social Investment Fund represent an integral part of the State Budget, the main source of financial data on spending for the WSS sector is the Ministry of Finance (MoF). Additionally, the National Ecological Fund, the National Fund for Regional Development, and the Social Investment Fund are primary sources of data on spending in the WSS sector. The summary of capital expenditures on the WSS sector as laid out in OECD (2011) is presented in the following table.

[23] "Supporting the Development of an Investment/Action Plan to Help Implement the New Strategy of the Government of Moldova for Water Supply and Sanitation," Annex II to the WSS sector Action Plan: Investment Plan, OECD, 2011.
[24] Republic of Moldova's WSS Strategy (Revised Version 2012), 2nd Draft, October 2012 - Technical Assistance for the Implementation of the Sector Policy Support Programme in the Water Sector

Table 2 Capital investment expenditures in the WSS sector

- million MDL -

Funding source	2008	2009	2010	2011	2012	2013
MoF transfers to central public authorities	16.8	2.1	22.9	312.12	239.57	120.46
o/w state budget sources	*1.9*	*-*	*1.32*	*11.36*	*4.55*	*-*
o/w donors and external credit sources	*14.9*	*2.14*	*21.55*	*300.76*	*235.02*	*120.46*
MoF special transfers to ATU	45.4	40.41	17.99	n/a	n/a	n/a
NEF (EcoFund)	7.4	38.15	85.72	n/a	n/a	n/a
National Fund for Regional Development	-	-	37.90	n/a	n/a	n/a
ATU budget allocations (incl. external donors)	199.58	174.95	321.60	n/a	n/a	n/a
Total	**269.12**	**255.65**	**486.09**	**312.12**	**239.57**	**120.46**

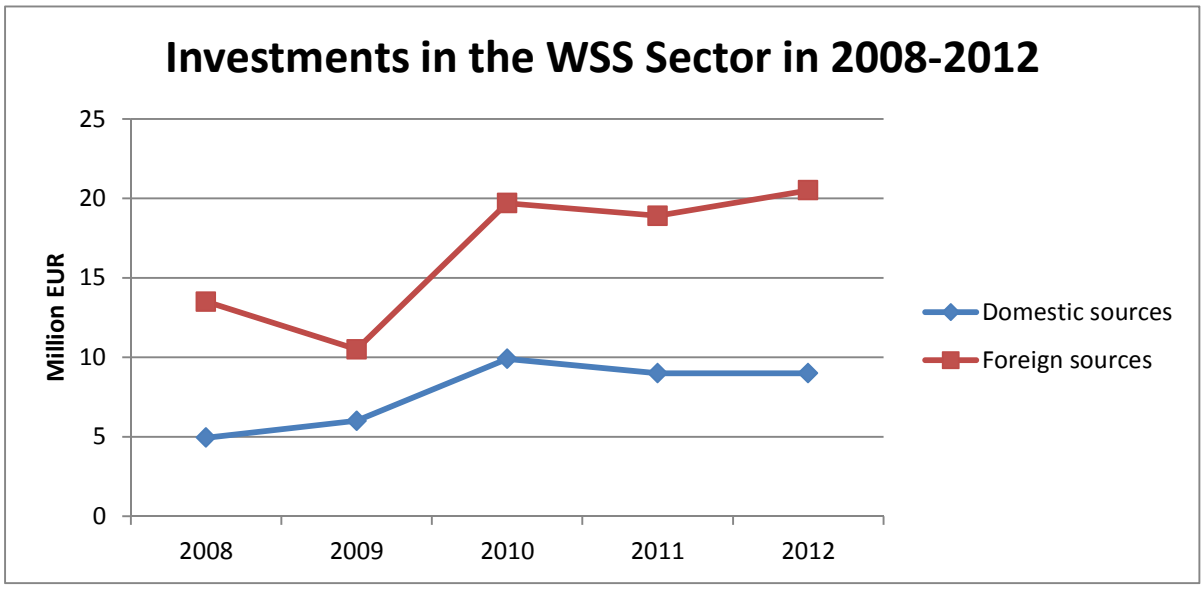
Source: OECD (2011)

Note: figures may not total due to rounding

At the time of the preparation of the mid-term Action& Investment Plan (December 2010), key data were not available for 2011. Thus, for example, the data presented in the row "MoF special transfers to the Administrative Territorial Units (ATU)" reflect for: 2008-2009 the executed budget; for 2010 the executed budget as of 27 December 2010; and for the period 2011-2013 the data were not available due to the fact that special transfers to ATU are clarified when the annual state budget law is adopted. The projection for 2011-2013 on ATU capital investments, including external financing for the WSS sector, was not available because the MTEF prepared by the MoF and central public institutions do not contain such data and no additional sources of information were found.

As part of the draft revised WSS Sector Strategy[25], an estimate was made on current spending in the WSS sector in Moldova. Based on available data, the total amount spent for investment in the WSS sector from 2008-2012 was about 1.92 billion MDL, or 120 Million EUR equivalent in total, with a high percentage contributed from foreign donors. The average distribution of finance between domestic and foreign sources is about 32% and 68%, respectively. These figures are consistent with the overall findings of the aforementioned OECD report.

[25] Republic of Moldova's WSS Strategy (Revised Version 2012), 2nd Draft, October 2012c - Technical Assistance for the Implementation of the Sector Policy Support Programme in the Water Sector.



Source: draft Revised Republic of Moldova's WSS Strategy

The OECD (2011) and the draft Revised WSS Sector Strategy estimates concur for the years 2008-2010. In 2011 and 2012, however, the WSS Sector Strategy shows higher spending figures than the Investment Plan, mainly due to the fact that additional information was available. If trends continue, about 7-9 million EUR of domestic funds are expected to be spent on the WSS sector and an additional 20 million EUR in 2013 from the international community.

Based on the total expenditures in the WSS sector (domestic plus foreign donors) reported in the revised WSS Strategy, the share of GDP of the Republic of Moldova spent on the sector was 0.4% in 2008, 0.44% in 2009, 0.7 % in 2010 and 0.5% in 2011-12. Including only domestic sources, spending for the sector was 0.11% in 2008, 0.16% in 2009, 0.23% in 2010, 0.16% in 2011 and 0.15% in 2012[26].

The main message from this analysis is that, over the period from 2008 to 2012, total spending on capital investments in the WSS sector was roughly 120 million EUR, or about 24 million EUR per year. Over the same period, direct financing of WSS sector investments from domestic sources (public spending in Moldova) and foreign sources (donors and bilateral aid) has ranged from a low 0.4% of Moldovan GDP (of which, 0.11% from national sources) in 2008 to a high 0.7% of Moldovan GDP (of which, 0.23% from national sources) in 2010.

3.2 WSS sector investment needs (2007-2027)

According to a 2007 OECD report, total financing needs (including both capital *and* operating expenditures) in the WSS sector for the 2007-2027 period range from 1.32 to 3.24 billion EUR, depending on the assumed targets (from rehabilitation and construction of critical infrastructure at the low end to full compliance with EU Directives and meeting Millennium Development Goals on water supply and sanitation at the higher end)[27].

[26] This is not a high figure. For example, Armenia spent more than 4 % of its national budget (or over 1% of GDP) on capital investments in the WSS sector for a number of years in order to make up for the long period of neglect.

[27] OECD, 2007, Financing Strategy for WSS sector. The high-end estimate was not deemed feasible in the report based on the fact that the associated investment needs would be well above the financial capacity of Moldova, as well

In the revised WSS Sector Strategy, sectoral investment needs for the 2013-2027 period are estimated at 705 million EUR, of which 194 million for urgent investment during the initial five-year period from 2013 to 2017. This level of investment is deemed affordable for Moldova, as it would require spending for WSS at the level of some 1-1.2% of GDP – a similar level was achieved in some EECCA countries (e.g. Armenia), where a strong political will for reversing the negative trend (and poor present situation) in WSS was in place.

The apparent discrepancy between the two sources derives essentially from the fact that OECD (2007) figures include operating and maintenance expenditures. Therefore, both sources can be deemed to provide consistent information on the long-term investment needs in the WSS sector in Moldova, or about 705 million EUR over the period from 2013-2027. The issue of climate change adaptation, however, was not specifically taken into account in these analyses.

As the figure from the revised Moldova's WSS Sector Strategy represents the level of compliance with water-related EC Directives deemed affordable for Moldova to achieve by 2027, hereinafter, it is assumed assume that, for 2013-2027, the total investment needs in the WSS sector are at some 705 million EUR. These estimates do not specifically take into account climate change adaptation.

Task 1 report established that water supply and sanitation development and adaptation of water supply and sanitation to climate change can be mutually supportive. This also applies to capital investment projects to be included in the National Plan for Flood Protection, which will be drafted and implemented with support from donors (EIB and others): e.g. construction of dams and multi-purpose water reservoirs will help to protect downstream settlements from floods, as well to secure water for irrigation and domestic water supply.

Also, current efforts aimed at clustering rural areas for the provision of water both increase the resilience to climate change and security of water supply for localities, but also improve services while choosing the most cost-effective means to do so.

Recent droughts in Moldova have shown that supply enhancements are needed, including increased storage, collection of rainwater, re-use of water and treated wastewater, reducing leakages and extracting groundwater. All of these measures are needed both for climate change adaptation, as well as to improve WSS services to the population.

The role of low-tech solutions in reducing investment needs of the sector

Implementation of simpler technologies, such as EcoSan toilets, can provide low-cost services to un- or underserved settlements, while reducing total investment needs. In addition, measures such as ecosystem adaptation, including restoring wetlands, using ponds, and protecting catchments to improve water quality can also reduce the amount of financing needed to provide WSS services. Such investments are less capital intensive, less costly to maintain, and easier to reverse if they prove untargeted.

3.3 Financing climate change adaptation in the WSS sector in Moldova

The willingness of Moldovan society to pay for adaptation will be influenced by its understanding of the risks faced, probability of occurrence, and expected damage, as well as the level of risk its society considers acceptable. Cost-sharing arrangements between national governments and local

as its capacity to absorb external financial assistance. In addition, it was found that it would *not* be possible for customers to afford to pay for services on that scale.

communities will also influence the approach taken to manage risks to water resources, and ultimately, the cost of doing so. For example, in cases where the cost of structural flood protection is partly or fully funded by national governments, while local communities bear the full opportunity cost of leaving flood plains undeveloped, incentives for local communities are skewed towards opting for structural approaches to manage flood risk, even if they may be more costly overall.

It follows that the implementation of the measures proposed in this document ultimately depends on: i) the awareness of the population of the risks related to climate change and its vulnerability to those risks, and ii) the coordination across levels of government.

This section explores how adaptation-specific finance can be mobilised in Moldova. Note that some instruments and sources of finance – such as efficiency gains or private sector participation – which will certainly be useful for financing the implementation of the revised WSS Sector Strategy, are not discussed here as they are not and will not be used specifically for adaptation.

3.3.1`The experience of OECD countries

Financing for adapting water systems has yet to be adequately addressed in most OECD countries. The adaptation strategies and plans of most OECD countries only briefly address financing issues, if at all. For the countries that have taken steps to addressing financing issues, several approaches have been taken. A few countries (e.g., France, Australia, Canada and Sweden) have allocated dedicated general adaptation funding from public budgets at the national level, some of which is allocated to water. Others (e.g., Germany and the UK) are mainstreaming adaptation actions into existing budgetary arrangements. Water-related support for adaptation is most often part of specific water programmes and projects (e.g., the Delta Fund in the Netherlands, Flood Prevention Programmes in the Czech Republic).

In general, it is difficult to separate out financing for climate change adaptation-related expenditure from ordinary water expenditure.

A few OECD countries have relied on international funding mechanisms to support adaptation activities. For example, Chile has received support to develop activities related to climate change from the Global Environment Facility (GEF), its implementing agencies and bilateral development co-operation partners. In 2010, the World Bank approved a USD 450 million loan for Mexico to develop public policies aimed at supporting the Mexican government's efforts to promote the adaptation of its water sector to climate change. The loan was intended to support government policies to contribute to the country's preparedness to confront the growing impacts of climate change through programs by the National Water Commission (CONAGUA).

The European Union provides some means to co-finance capital-intensive investment in water infrastructure and help EU Member States comply with water legislation through EU Structural and Cohesion Funds. For management of water resources, EUR 8 billion in total funding is provided for reducing leakage rates, connecting to water supply, developing additional supply and improving infrastructure. For disaster prevention, EUR 7 billion is available. The Solidarity Fund (EUSF) provides funds for disaster relief in member states; around EUR 1 billion is allocated each year. Estonia's various activities concerning water management and climate change are financed in large part by the Cohesion Fund. In Slovenia, there are two ongoing flood defence projects receiving support from the EU Cohesion Fund. In Hungary, flood protection will continue to benefit from EU support in the frame of Environment and Energy Operational Programme (EEOP), for which EUR 607 million has been allocated over the period of 2007-2013.

Several OECD countries and the European Union are exploring innovative financing mechanisms to address climate change adaptation and water. Examples include:

- In Denmark, the government is currently scrutinizing water sector legislation in order to prepare a new law proposal related to the financing of climate change adaptation of the water sector. The purpose of this work is to increase the possibilities for Danish water and sewer companies to finance more intelligent and socio-economic optimal climate change adaptation measures. For example, the proposal could make it possible for sewer companies to co-finance new measures on roads and in waterways, which keeps rainwater out of the sewer system.
- The European Commission is considering the use of revenues generated from auctioning allowances under the Community greenhouse gas emission allowance trading system (EU ETS) for climate change adaptation. The EU White Paper Adapting to climate change: Towards a European framework for action (2009) supports the possibility of using such revenue for adaptation purposes. The revised Directive governing the EU ETS provides that at least 50% of the revenue generated from auctioning allowances should be used, inter alia, for adaptation in Member States and developing countries. The EU is also exploring the potential implementation of payments for ecosystems services linked to natural water retention measures aiming at the prevention of floods and droughts.
- The German Federal Government is examining the possibility of including aspects of climate adaptation in Federal funding programmes and joint funding instruments financed by the Federal Government, the Lander and the EU. The recent incorporation of adaptation into the funding instruments of the National Climate Protection Initiative is an example. The Federal Government also has a scheme to fund innovative initiatives and demonstration schemes at local and regional level. This scheme provides financial incentives to adaptation frontrunners to foster innovation and to spread awareness about the necessity of adaptation. At the end of 2011, the Environment Ministry (BMU) introduced a funding scheme promoting adaption to climate change at the level of individual enterprises and local authorities. This funding is expected to cover networking and education projects at the local/ regional levels and support for drawing up adaptation concepts.
- Mexico's 2030 Water Agenda proposes to establish an Adaptation Contingency Fund that would improve Mexico's capacity to effectively replace or significantly modify water supply systems and flood systems. CONAGUA is still analysing alternatives for implementing the Fund. The recently adopted General Law for Climate Change specifies the need to create a fund for projects, studies, actions. In addition, since 2006, Mexico has been selling catastrophe bonds ("cat bonds") each year as an innovative form of risk financing. If a disaster occurs during a bond's lifetime, the government uses the money borrowed to pay for repairs. If no disaster occurs, the government pays the money back with interest. The latest such bond was issued on 15 October 2012 and raised 315 million U.S. dollars.

3.3.2 Regulatory instruments to address climate change adaptation in the Moldovan context

Regulatory instruments that are recommended in the Moldovan context of adaptation to climate change focus on the knowing, capping and managing risks to water resources. The revised Moldova's WSS Sector Strategy also includes regulatory instruments, including strengthening the

legislation governing the sector. The main instruments applicable to the adaptation of WSS to climate change are presented in section 1.2 above, which are:

- **Sustainable water abstraction limits** (cap the risk) – where it is not possible to set water prices to take into account water scarcity (for example, due to concerns over equity in access to water), water abstraction limits should be set and enforced in areas affected by acute and chronic drought
- **Integrate climate change impacts in building and construction codes** (cap the risk) – new construction rules/technological standards should be specifically established for WSS
- **Integrate climate change impacts in land-use and urban planning** (cap the risk)
- **Multi-year plans and projects** (manage the risk) – climate change must be factored in to all forms of multi-year plans, including IWRM plans at the basin level, country-wide flood management plan, national plan for managing natural hazards (drought, extreme temperatures, winds, etc.), and master plans for the development of WSS services are the national and rayonal levels. At the same time, the water demand management plans should also help identify efficiency gains that can reduce both O&M costs and the need for new infrastructure investments.

3.3.3 Economic instruments to address climate change adaptation in the Moldovan context

Economic instruments used for WSS in general and for climate change adaptation in particular should contribute to achieving the objectives of efficiency, equity and adaptive efficiency. Efficiency is focused on maximising welfare obtained from water resources by allocating it to its most valuable economic use. Equity, on the other hand, concerns the distribution of resources across a given population. The principle of adaptive efficiency addresses the least-cost path to maximise social welfare over the long-term in the context of resources that are subjected to risk and uncertainty, as in the case for water resources affected by climate change[28].

Tariffs and water pricing

Pricing of WSS services should be viewed in terms of three key aspects: cost recovery, efficiency, and scarcity. OECD has developed the "3Ts" concept which assumes that (a) there are three *ultimate sources* of financing for WSS services Tariffs (user charge revenues), Taxes (domestic solidarity) and Transfers (meaning donor grants and loans, and charity i.e. international solidarity); and (b) that the capital and recurrent costs of WSS service should be covered from an appropriate mix of the 3Ts. Ideally, operating and maintenance (O&M) costs should be fully covered from user charge revenues (as financing the gap from public budget and/or donor grants is not a sustainable solution).

Achieving efficiency in water supply and wastewater collection and treatment (and ultimately, in water resource utilisation), however, also requires institutional measures, such as local and national water regulation and water demand management plans to reduce the need for new infrastructure and motivate service providers to reduce costs. Otherwise, service providers may seek to charge whatever price they think customers would pay in order to maximise return. Thus, regulation is also required to ensure equity of access to water supply (and sanitation).

[28] Water and Climate Change Adaptation: Policies to Navigate Uncharted Waters, OECD, 2013 (forthcoming).

If water tariffs exceed assumed affordability limits (as it is often the case now in Moldova), in order to ensure that low income households can afford access, direct social assistance should be provided as the preferred measure.

In Moldova, tariff rates started from very low levels hardly covering just full operating costs in 1990-ies, and have been growing since quite significantly. To mitigate negative social impacts of a tariff increase, water users need to be able to adjust their consumption in order to manage their budgets; therefore water use needs to be metered. However, metering is costly – this calls for a sound metering strategy, carefully weighing marginal costs and benefits of improved metering for consumers and water utilities. This is topical for Moldova, as cheap but low quality meters, while improving incentives and collection efficiency, may substantially under-report true consumption, thus undermining revenues of water operators.

Water tariffs, however, focus on the covering of costs based on existing infrastructure that needs to be maintained and expanded. As such, they focus on the historic costs of providing services and projections of these costs into the future.

Water scarcity is typically not factored into the price of water; during periods of drought, water prices should reflect this scarcity and be used to manage water demand.

Water scarcity pricing could be used to promote efficient use of water resources as well as prioritise allocation toward the uses of water that generate the highest net benefit. Water scarcity pricing also serves adaptation needs.

However, affordability constraints should also be taken into account here. As discussed in the revised WSS Strategy and the Task 3 Report, in Moldova, the affordability of water and sanitation tariffs are near or exceed assumed limits. This represents a constraint for introducing water scarcity pricing in Moldova.

Furthermore, in some cases, the objective of achieving full O&M costs recovery by tariffs may well contradict to achieving the equity objective.

The price of water for non-domestic users should also serve the objectives of efficiency, equity, and adaptive efficiency. Water prices for commercial enterprises, industrial users, and agriculture should also be set to reflect the costs of providing the service, as well as scarcity in times of drought. Taking into account that during the periods of water stress, domestic water supply is always the highest priority, while supply of most industries and irrigated farming can be somewhat compromised, there is some room for introducing water scarcity pricing in Moldova – for industries and farmers. For example, in time of droughts, reduced water abstraction limits could be applied jointly with higher water abstraction fee and water supply tariff, thus creating economic incentives for further reducing water consumption.

This will motivate investments in efficiency in water use in industries and irrigated farming. Since the price of irrigation water may exceed the ability of farmers to pay, however, as with WSS tariffs, the Government of Moldova could consider providing funds for efficiency investments in irrigated farming (such as drip agriculture) until farmers can afford to pay the tariffs that also reflects water scarcity in times of drought. Water prices that cover the costs of delivering the water to the farmer, as well as reflect water scarcity, should still provide some incentive to use irrigation water efficiently.

Pollution taxes and charges can be better used to protect the quality of water resources. Such taxes and charges send a signal to reduce activities that threaten the quality of water resources, as

well as provide a source of financing for less polluting alternatives. On the revenue recycling side, these charges can be accumulated in a dedicated fund with a clear mandate for investments in developing WSS infrastructure, setting adaptation to climate change as a priority. However, the fiscal role of pollution charges is secondary vis-a-vis the incentives for reducing pollution.

Options for earmarking some proportion of revenues generated by fiscal economic instruments for financing adaptation needs in Moldova are discussed in the next subsection.

"Non-conventional" economic instruments

Flood insurance has a long history of use for dealing with climate variability and weather risks. If flood insurance policies are designed correctly, they can reduce exposure and vulnerability to risk and facilitate adaptation to climate change, by discouraging construction in high-risk areas through high-risk premiums. Conversely, premium discounts can be awarded for risk reduction. In many countries, however, private coverage is not available and even when it is, the national government functions as an insurer of last resort. Private flood insurance, without public reinsurance, exists in the United Kingdom.

In Moldova, however, flood insurance is likely to prove too expensive for property owners. Land-use and/or urban planning regulations would be more effective in reducing flood risk. To make flood insurance more affordable, the Government of Moldova could consider adjusting (reducing) property tax rates in flood-prone areas for the immovable property which is insured against the risk of flood. If flood insurance is used, the national government should anyway discourage settlement and development in high-risk areas (e.g. in so called "red zone"), by signalling that it will not function as an insurer of last resort if settlements, production facilities or housing units are built in areas designated as high flood risk.

Real options

Real options are an approach to decision-making that incorporates the value of flexibility. A "real option" is an alternative that can be enacted, adjusted or discarded as new information is obtained. This approach works best in sectors where projects are scalable, for example when villages whose water supply is most vulnerable to climate change can be addressed first. As more information becomes available, new investment priorities can be set. This approach is in contrast to making large investments in water supply before there is a need (for example, by constructing a large water main for connecting many rural settlements and then having no mechanism to connect individual households in those areas to the water supply - the "last mile" problem). Real options analysis is similar to cost benefit analysis, except that it utilises decision trees and probabilities of key events occurring at decision points and calculates the net present value of the consequences (costs and benefits) of pursing each decision. Real options analysis is used in the United Kingdom.

It is recommended to consider using this approach in Moldova as part of measures to improve project preparation and "manage the risk" of climate change on the WSS sector (master planning, feasibility studies, benefit-cost analyses, etc.).

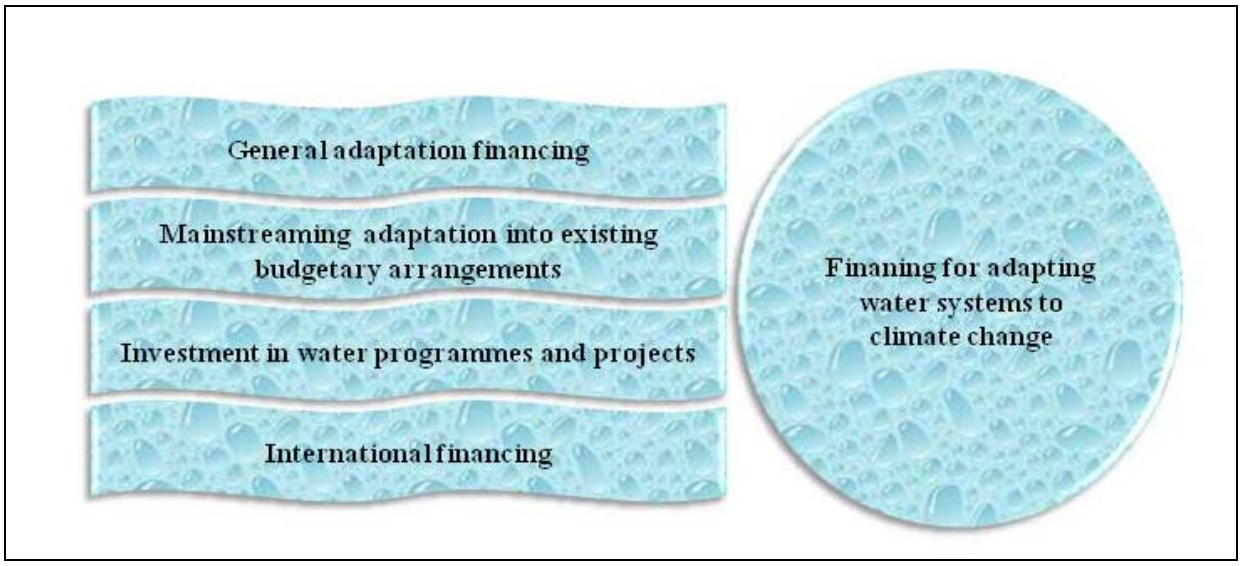
3.3.4 Financing WSS sector adaptation in Moldova

International experience

A recent inventory confirms that financing for adapting water systems has yet to be adequately addressed in most OECD countries (see OECD, 2013, forthcoming). The adaptation strategies and plans of most OECD countries only briefly address financing issues, if at all. For the countries that

have taken steps to addressing financing issues, several approaches have been taken (see Figure below). A few countries (*e.g.* France, Australia, Canada and Sweden) have allocated dedicated general adaptation funding from public budgets at the national level, some of which is allocated to water. Others (*e.g.* Germany and the UK) are mainstreaming adaptation actions into existing budgetary arrangements. Water-related support for adaptation is most often part of specific water programmes and projects (*e.g.* the Delta Fund in The Netherlands, Flood Prevention Programmes in the Czech Republic). In general, it is hard to separate out financing for climate change adaptation-related expenditure from ordinary water expenditure. A few OECD countries (*e.g.* Chile, Estonia, Hungary, Mexico, Slovenia, and Turkey) have received funding from international funding mechanisms (including EU Structural and Cohesion Funds) to advance adaptation of water systems. In addition, several countries (*e.g.* Germany, Denmark, the U.S., Mexico, and France) as well as the EU are exploring innovative financing mechanisms for adaptation.

Figure. Various financing sources for climate change adaptation and water



Source: Based on OECD (2013, forthcoming), Water and Climate Change Adaptation: A Survey of Policies in OECD Countries, www.oecd.org/env/waterandclimate.

These approaches can be used to discuss financing options in the Moldovan context.

General adaptation financing: user charge revenues

A recent technical note[29] and the "Viable Business Models" Report (Task 3 Report)[30] examined in detail the affordability of water supply and sanitation services in Moldova. They indicated that affordability limits of water bills have been reached for much of the population in Moldova, in particular in rural areas.

However, tariffs for water services should contribute to financing adaptation measures in the water sector, as they are the most reliable and sustainable source of finance over the long run.

Thus, in order for water operating companies to remain viable and be able to maintain infrastructure, a strong social support system and other solidarity mechanisms well-targeted at vulnerable households are needed. The preferred option is that tariffs reflect the true operation and maintenance costs of service provision, while vulnerable households receive targeted assistance from the government and/or other solidarity mechanisms. But even if such a system is created any

time soon, tariffs could become a main source of financing for adaptation of the sector to climate, as well as for other improvements if WSS services, only in the long run, taking into account present low household incomes in Moldova.

International financing

Transfers from Donors and IFIs

The level of donor financing has been discussed in section 3.1 and currently is on the level of about 16-20 million EUR per year. While this number needs to increase, the Government of Moldova should increase its capacity to develop projects and present them as priorities for financing. As demonstrated in a recent OECD project[31], the number of developed projects in the WSS sector is below the financing that is currently available based on past and current declarations and commitments by donors. This includes projects dedicated to adaptation. The absorptive capacity of Moldova needs to be raised in line with donor support. This in turn will increase donor support, as well as ensure that it is targeted toward the actual priorities of the Government of Moldova.

Overall, this would help Moldova realise the significant scope to expand the contribution of the international community (international solidarity) to the development of the WSS sector in Moldova, including adapting it to climate change.

Access to international carbon funds

Carbon funds, financed from emission trading systems, can be a source of financing (in the form of grants or soft loans) for climate change adaptation provided the proposed intervention is in fields such as energy efficiency, carbon sequestration, and adapting land use to climate change. Thus, replacement of inefficient water pumps would qualify as improved energy efficiency. Wastewater treatment, in particular when biogas is captured and used to produce energy, would also qualify for financing. However, to use this option, the capacity of Moldova to prepare respective projects needs to be substantially increased. Good news is that such capacity development is envisaged in the revised Moldova's WSS Sector Strategy.

Projects to improve degraded land can also be a source of financing for climate change adaptation. For example, in October 2012, it was announced that the World Bank's BioCarbon Fund purchased carbon credits generated by the Moldova Soil Conservation Project. This was only the second land use and land-use change project to be registered with the United National Framework Convention on Climate Change (NFCCC) and the first to issue carbon credits in Moldova. The project involved cooperation from the Moldova Forestry Agency *Modsilva*, the Forestry Research and Management Institute, private forestry partners, local communities, and the World Bank. Since 2003, a World Bank-supported project has achieved restoration of over 20,300 hectares of these severely degraded lands by planting trees and improving the quality of the earth.[32].

Thus, the climate change adaptation measures aimed at restoring degraded lands, which impacts surface water quality and flows, indeed can be financed from carbon funds and emissions trading mechanisms.

[31] "Supporting the Development of an Investment/Action Plan to Help Implement the New Strategy of the Government of Moldova for Water Supply and Sanitation," Annex II to the WSS sector Action Plan: Investment Plan, OECD, 2011.

[32] http://www.worldbank.org/en/news/2012/10/24/world-bank-helps-moldova-restore-degraded-lands-and-earn-carbon-credits

Dedicated adaptation funding from public budgets at the national level

Some proportion of Taxes and Transfers could and should be allocated towards WSS sector adaptation needs (in addition to other water sector priorities). First and foremost, adaption measures in the WSS and other sectors should be mainstreamed into existing budgetary arrangements, for example by specifically identifying them as such within the medium-term expenditure framework (MTEF).

On top of allocations from the general budget, some dedicated instruments and mechanisms could be considered in Moldova.

Dedicated (target) funds. At present, there are two such funds in Moldova: NEF replenished by collected pollution charges and fines, and NFRD (each year 1% of the national revenue budget is allocated to the NFRD). Both funds allocate up to 30% of their budget for WSS: for sanitation projects (NEF) or for WSS projects in general (NFRD). Out of these two funds, the NFRD is a larger and more predictable source of finance.

Dedicated National adaptation fund and/or National water fund could be established in Moldova to finance specific adaptation projects (and eventually other priority projects in the water sector, in case of the water fund), as well as leverage financing from similar funds at the international level. Since investment needs in the WSS sector in Moldova are significant while the incremental costs associated with adaptation of the WSS sector to climate change are small (less than 2% of total estimated investment needs in WSS, see section 2.1 above), it is likely that the former fund would duplicate the activities of other funds in Moldova with respect to the WSS sector.

A National water fund would make more sense. In Moldova, the idea of introducing a 1% surcharge on WSS tariffs and accumulating it in a national water fund is already under discussion.

However, creation of yet another dedicated fund on top of existing ones (NEF, NFRD, SIF and an emergency fund run by the Parliament) might be a less preferred option than extending the mandate of one of the existing funds to adapting local water utility infrastructure to climate change, and allocating extra resources for this purpose.

The best candidate is probably the NFRD as it already has mandate and allocates substantial resources for developing WSS (up to 30% of its budget) and other local infrastructure. The change may require a small adjustment of its project selection criteria so that to rank projects with multiple expected benefits, including adaptation to climate change, higher than others.

The same change could be made in the selection criteria applied by other existing dedicated funds (NEF, SIF).

Repayable domestic sources of finance: micro-finance, infrastructure banks or revolving funds

Micro-finance is currently used in Moldova to finance the large small and medium-size enterprise sector that contributes significantly to Moldovan GDP. Many institutions provide micro-financing; for example Microinvest, established by the Soros Foundation Moldova and the Moldova Microfinance Alliance, provides development financing to small business initiatives in rural and urban areas in

the Moldova. In 2011, it had a gross loan portfolio of USD 17.9 million, 5,118 active borrowers, and an average loan balance per borrower of USD 3,496.20[33].

Micro-financing could be used to finance certain measures for climate change adaptation, such as purchase of storage tanks for rain water and individual Ecosan toilets for sanitation. Customers could use micro-finance directly, or through a governmental programme to facilitate the use of micro-finance for adaptation of WSS to climate change.

A **revolving fund** is essentially capital that is raised for a certain purpose that can be made available to the same user more than once. This capital circulates between the fund and its users. While revolving funds should be financially self-sufficient and sustainable, they must first be capitalised so they can offer financial products. Revolving funds are typically capitalised from government money (taxes) or from official development assistance (transfers). These funds can also be capitalised from carbon trading mechanisms (carbon funds) provided the money is used for adaptation measures. In order to be financially sustainable, revolving funds typically issue low-interest loans that must be repaid in full (or if the fund is recapitalised on a regular, sustainable basis, the last 10-25% of the remaining debt can be written off by the lender).

This provides an incentive to develop projects of a scale that is actually needed as well as encourages payment discipline. For instance in Poland, revolving funds are used to finance energy savings and efficiency projects, as the generated savings can be used to repay loans and no grant mechanisms are required. Same approach could be used in Moldova for adaptation projects.

In the case of Moldova, a revolving fund could be established from scratch, or an existing fund could be transformed into such a fund. Either way, clear project cycle management procedures would need to implemented and followed in the appraisal, evaluation, selection, and financing of each project. Such clear procedures could attract the interest of donor funds that could be used to capitalise the fund. Ultimately, such a fund should issue low interest loans and avoid grants (except for non-investment projects, such as feasibility studies) as the main source of financing investments. If the fund could also be capitalised through water abstraction fees, water pollution charges and penalties, it would be possible to forgive a small percentage of outstanding debt as a reward for timely payments throughout the loan repayment period.

Such funds should also be permitted to invest in other financial instruments, such as government bonds and (to a limited extent) stock markets.

The best course of action for Moldova is to transform an existing mechanism – such as the National Ecological Fund (NEF) – into a revolving fund once its project cycle management procedures meet international standards and potential beneficiaries have sufficient creditworthiness to finance and repay loans. Grant-only financing schemes – as is currently the common practice in Moldova – are not compatible with revolving funds.

The role of solidarity mechanisms in making adaptation more affordable

Protecting most vulnerable villages fully dependant on shallow wells from drought, by shifting to more reliable sources of water (surface water or deep boreholes/confined aquifers) was identified as a priority measure for adapting water services and WSS infrastructure to climate change.

[33] http://microinvest.md

This is a priority measure indeed which cannot be postponed till distant future. However, the capacity of the government to fully fund this measure, even with donor support is limited. Experience of the ApaSan project funded by SDC suggests that the shift from shallow wells to more reliable sources of water, more resilient to climate change impact, could be accelerated if households also provide contribution, both in kind and in cash.

However, cash contribution is often a problem for poorer rural households, partly due to uneven cash inflow – typically, farmers receive most of their cash income after the have sold their harvest.

To address the affordability problem, informal “mutual support funds” have been created by some Water Users Associations (WUA) developing rural piped water supply systems with support from the SDC-funded APASAN project: richer WUA members make contribution in cash for poorer households/members which are temporary short of money, while the latter pay back their debt later on when their financial situation improves.

Overall, taking into account the fiscal situation and tough affordability constrains in Moldova, there is a clear need to strengthen existing and eventually introduce new cost-effective domestic solidarity mechanisms for WSS in Moldova, including for adapting WSS to climate change.

3.4 Conclusions

In OECD countries, the costs of climate change adaptation are expected to add to an already substantial financing gap for water systems. On the one hand, robust infrastructures are in place, which may need to be upgraded to meet increasingly stringent health and environmental regulations. On the other hand, the infrastructures were built before climate change emerged as a stressor, and a significant effort is needed to adapt.

Moldova is in a different situation. It is essentially lacking appropriate infrastructure for water supply and sanitation services in large parts of the countries: existing infrastructures need to be rehabilitated and rebuilt; new ones need to be built. This creates an opportunity to *build right from the start*: if climate change is factored early in infrastructure design and construction, the incremental cost of adaptation will be minimal. This report suggests that it could amount to 2% of the expenditures required to upgrade and expand water services.

A number of steps can be taken to minimise risks and impacts related to climate change. Typically, avoiding settlements and constructions in flood prone areas can contribute to this. Additional steps can spread the burden on several users. At the moment, the costs of adaptation or remediation are met by the public purse (public budget or international donors); mechanisms such as insurance schemes can harness other users, who will benefit from enhanced security.

A variety of options can be used to cover the costs of adaptation measures. Obviously, revenues from user charges should cover parts of this cost, in the medium term; appropriate accompanying measures are required to address affordability issues. Taxes need to contribute, as adaptation has a public good dimension. Moreover, Moldova allocates a comparatively small share of its national budget to water. New sources of finance could be considered, including carbon finance, which is already available in Moldova.

Several mechanisms can be used to channel budgetary resources to water adaptation measures. The best one will minimise transaction costs, and make sure that earmarked funds are used for priority measures. Any option will have to be assessed on a regular basis, and reformed if need be.

The report confirms that adaptation measures are appropriate, affordable and timely on the water policy agenda in Moldova. They need to be thoroughly planned and managed, but any delay in this domain will generate additional risks for the population, the economy and the environment, and will necessitate more expensive responses in the future.

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Annex A: Assessment of adaptation measures

The adaptation measures recommended in this document are based on the list of possible priority measures set out in the Task 1 Report. The main measures to be considered to adapt water services and water infrastructures to climate change in Moldova were developed using a risk-based approach developed by OECD and discussed in a recent paper[34]. Accordingly, the role of the Government of Moldova is to "know", "cap" and "manage" water risks associated wit climate change. For example, policy responses to help "know" the risk may be necessary to overcome information failures, such as the lack of needed hydro-meteorological data, or data on water resources and the status of WSS infrastructure to assess the risks associated with climate change, or asymmetric information, or cases where private actors are not fully aware of climate change impacts and the risks they entail. "Knowing the risk" requires the incorporation of both scientific and technical inputs along with economic, social and cultural considerations. For example, risk perceptions should not be overlooked, as they influence the demand for risk management, the willingness to pay for risk reduction, and influence judgements about who is responsible to manage the risk[35].

"Capping the risk" requires determining the acceptability and tolerability of a given water risk. It should rely on both evidence- and values-based judgements. Governments should facilitate a process to engage key stakeholders in the decision-making through democratic procedures, and may need to account for potential "risk-risk" trade-offs. These may occur when efforts to reduce a given risk (e.g. water shortage) for one group of users, such as farmers, may increase other risks (e.g. resilience of freshwater systems) affecting other users, such as fish/aquatic biodiversity. For example, structural flood protection for one community may increase flood risk for the neighbouring community. Reducing risk of shortage upstream by increasing storage capacity may increase the risk of shortage for downstream users. These co-ordination failures may require a government response. Weighing risk-risk trade-offs can help identify "win-win" strategies and reduce inefficiencies and inequities[36].

In terms of "managing the risk", governments need to address institutional and regulatory barriers that may inhibit timely and efficient adaptation, taking into account the agreed acceptable levels of risks. While sound water policy generally facilitates climate change adaptation, some existing water policy settings may dull incentives to adapt to climate change and may need to be adjusted. Governments can follow several "rules of thumb" to facilitate more timely, efficient and equitable adaptation. These include:

- Exploiting "no regrets" and "low regrets" options (typically, with multiple benefits or low cost) by prioritising options viable under all plausible futures
- Identifying and facilitating low cost, flexible (if possible, reversible) options: consider the full range of risk management options ("avoid", "reduce", "transfer" or "bear" the risk) and adaptation options (e.g. "green" as well as built infrastructure). Considering climate change

[34] Water and Climate Change Adaptation: Policies to Navigate Uncharted Waters, OECD, 2013 (forthcoming).

[35] *Ibid.*

[36] *Ibid.*

adaptation early in the planning and project cycle projects can be much cheaper than building add-ons or retro-fitting later

- Considering expected costs and benefits of adaptive actions. This may require using a discount rate appropriate for long time frames
- Minimising timing errors, as responses are likely to be either too early or too late. Adopting a flexible approach to planning and investments under uncertainty for long-lived, climate sensitive water infrastructures with high sunk costs
- Reducing or removing barriers to internalise climate risks. This includes overcoming information and co-ordination failures and institutional or regulatory barriers that dull or remove incentives to manage risk and adapt to long-term change
- Explicitly addressing risk implications of water policies. This requires the clarification of roles and responsibilities, assigning risk to actors able to manage them most efficiently, ensuring equitable risk sharing arrangements, while taking into account environmental needs[37].

Based on this approach, the possible priority adaptation measures for WSS in Moldova set out in the Task 1 Report are briefly discussed below.

1. Know the risks

Measures to help "know" the risk are necessary to close information gaps and increase awareness in the government and the public of climate change impacts and the risks they entail. Proposed measures are:

- Improve hydro-meteorological monitoring system to obtain timely and reliable data for the assessment and management of main risks of weather and water-related disasters
- Develop disaster and climate risk assessment system, as a basis for urban and rural infrastructure planning, especially in most vulnerable areas
- Upgrade of existing disaster management structures (e.g. the Civil Protection and Emergency Situations Service, CPEES) or set up a national center (and eventually local centres in Prut and Dniester basins) for weather and water related disasters preparedness, risk assessment, and management, in coordination with Ukraine and Romania, as appropriate. Set up a national centre (and consider local centres in Prut and Dniester basins) for weather and water-related disasters preparedness, risk assessment, and management
- Conduct inventories of current conditions of water and sanitation infrastructure in order to inform decisions on how best to cap and manage risks to WSS of climate change and guide investment decisions.

Each of these is discussed briefly below.

Improve hydro-meteorological monitoring system

The hydro-meteorological monitoring system in Moldova needs to be substantially improved in order to obtain timely and reliable data for the assessment and management of main risks of

[37] Water and Climate Change Adaptation, *op. cit.*.

weather and water-related disasters. The data from this system should be used also for making investment decisions related to water storage, as well as for informing populations most at risk about impacts of climate change, in particular droughts, floods, and extreme weather events.

While this measure is required for adaptation of the WSS infrastructure to climate change, it is not considered an incremental expenditure as it should occur regardless of climate change adaptation activities in WSS.

Develop disaster and climate risk assessment system

It should serve as the basis for urban and rural infrastructure planning, especially in most vulnerable areas.

At present, the legal and institutional framework for disaster risk management in Moldova is mostly oriented toward emergency response, rather than preventing risks and hazards. Institutions in natural hazard mitigation in Moldova can be roughly divided into coordinating emergency commissions, early warning and prognosis bodies, line ministries, and disaster management bodies. Although there is an adequate legal and regulatory framework in place, there is a need to improve coordination and contingency planning and undertake an integrated approach to risk management, foremost for the risks of natural hazards associated with climate change. Capacity development is necessary at every level of the disaster management structure.

Disaster and climate risk assessment in Moldova should be implemented after a review of past, on-going, and planned projects dealing with these issues. It is assumed that the disaster and climate risk assessment for the country as a whole will need to be developed by an external consultant. This should lead to development of disaster and climate risk maps, which should provide the basis for outline plans to be developed for all localities.

The World Bank is currently financing the Disaster and Climate Risk Management Project[38] that includes components aimed at improving weather forecasting capacity, improving disaster preparedness (through the Emergency Command Centre), and initiation of activities for adaptation to climate risks in agriculture (providing weather information to farmers via mobile technologies and grants for practical application of agricultural technologies aimed at increasing resilience to climate risks). The project is due for completion in 2014.

On the other hand, a disaster and climate risk assessment of WSS Sector resources and service provision is also required. Such a study should develop a flooding and drought national risk profile, with maps, a strategic framework and action plans for the integration of disaster risk management into urban planning and development in the Republic of Moldova. This study should include an assessment and mapping of the vulnerable sites with regards to flooding and drought and include the development of a national framework for vulnerability assessment, the planning mechanisms, formulation of Disaster Risk Reduction (DRR) policies, guidelines, adaptation strategies and action plans to respond to climate change related disasters in the years to come.

While this measure is required for adaptation of the WSS infrastructure to climate change, it is not considered an incremental expenditure as it should occur regardless of climate change adaptation activities in WSS.

Set up a national centre for weather and water-related disasters preparedness, risk assessment, and management

[38] Project P115634

A national centre should be established (e.g. by upgrading existing disaster management structures, such as the Civil Protection and Emergency Situations Service, CPEES) that is charged with collecting and analysing weather and water flow data.

Based thereon, the centre then prepares risk assessments and plans to manage those risks. The establishment of local centres in the Prut and Dniester basins should also be considered.

While this measure is required for adaptation of the WSS infrastructure to climate change, it is not considered an incremental expenditure as it should occur regardless of climate change adaptation activities in WSS.

Conduct inventories of current conditions of water and sanitation infrastructure

These inventories should be conducted in order to inform decisions on how best to cap and manage risks to WSS of climate change and guide investment decisions.

An inventory of existing and properly functioning water supply and sanitation facilities should provide an overview of facilities in general and allow an assessment as to how and to what extent WSS facilities in Moldova are exposed to climate change impacts. The inventories should be conducted of water sources (boreholes, shallow wells, surface), water treatment facilities, water supply infrastructure, and sanitation facilities (networks, treatment plants, other, decentralised sanitation facilities).

A **methodology** is required by which the technical and operating condition of WSS systems in localities can be assessed. As a first step, this methodology requires a **diagnostic list** of issues that should be inspected at the relevant localities. This diagnostic list should include technical, operational, financial, and institutional issues, such as:

- Age of WSS infrastructure components, broken down by type of assets
- General assessment of technical condition, based on visual inspection, repair records, and reports from operating personnel
- Comparison of manufacturer-reported capacities with actual capacities
- Actual operating time, planned shut-downs (number and hours), unplanned shutdowns (number and hours) during 12-month period
- Number of customers using the system and percentage of those formally connected actually using the system; number of potential additional customers
- Operating costs of infrastructure: electricity, transport, treatment chemicals, personnel, spare parts
- Number of operating personnel, administrative personnel
- Billings (amounts billed, in m3 and MDL) and actual collections (MDL)
- General assessment on the reasons why the infrastructure is not operational, if applicable
- Commitment of local operating company, local authorities, etc. to maintaining the infrastructure.

Inventories should also be made in order to identify localities without safe access to water and/or sanitation. This information should be used to inform the development of master plans and feasibility studies for priority WSS projects. Therefore, this activity is considered as a top priority, and an incremental cost compared to the revised WSS Strategy, as well as other objectives currently being pursued by the Government of Moldova.

A budget of 900,000 EUR should be allocated to these measures.

2. Cap the risks

"Capping the risk" requires determining the acceptability and tolerability of a given water risk. It should rely on both evidence- and values-based judgements. The GoM should engage key stakeholders in decision-making. To this end, the measures in this group are identified to engage and modify the behaviour of water users in Moldova:

- Raise public awareness for water conservation and water protection behaviour
- Inform populations about water-related risks and the potential impacts of climate change
- Assess the level of security people are willing to reach; inform them about the costs and constraints associated with alternative levels of security

Each of these is discussed briefly below.

Raise public awareness for water conservation and water protection behaviour

National and local public awareness campaigns should be conducted with multiple objectives to raise awareness for the importance of saving water, not only during drought periods, and protecting water resources; and to inform populations about water-related risks and the potential impacts of climate change, as well as about the costs and constraints associated with alternative levels of security. These campaigns should be included in the overall campaigns and information activities considered under the Water SPSP and revised WSS Sector Strategy. The consultation process aimed at reaching an agreement on acceptable levels of risk should be part of the ongoing political process in Moldova. Therefore, no additional incremental investments are assumed.

3. Manage the risks

Measures aimed at "managing the risk" involve the need for the Government of Moldova (GoM) to address institutional and regulatory barriers that may inhibit timely and efficient adaptation. Foremost, "no regrets" and "low regrets" options should be identified that are applicable in all plausible futures. To that end, the following measures are included:

- Develop and implement IWRM plans at basin level, while factoring in climate change
- Develop and implement a country-wide flood management plan, including preventive measures; adjust land use planning, building and construction codes to discourage activities and construction in flood prone areas;
- Develop and implement a national plan to manage other climate related natural hazards (such as droughts, extreme heat and frost, strong winds, landslides, etc.)
- Improve water use efficiency – related activities should be part of respective sectoral programmes and water demand management plans, foremost in the irrigation and WSS sectors, as well as in water-intensive industries
- Improve and/or create flood warning systems in Prut and Dniester basins
- Coordinate hydro-meteorological monitoring, risk assessment and risk management activities in trans-boundary basins with neighbouring countries: Romania and Ukraine.

Each of these measures is discussed below.

Develop and implement IWRM plans at basin level, while factoring in climate change

In times of drought, water demand for uses such as irrigation increase and at the same time, as seen in the droughts of 2007 and 2012 in Moldova, water resources from shallow wells can completely dry up. As economic growth continues and incomes increase, the demand for water can be expected to increase. This will require authorities to apportion diminishing water supplies between ever-increasing demands. The traditional fragmented or purely sectoral approach is no longer considered viable. Internationally, an integrated, cross-sectoral approach to water policy has been accepted as the best way forward.

According to the Global Water Partnership (GWP), Integrated Water Resources Management (IWRM) is a process that "promotes the coordinated development and management of water, land, and related resources in order to manage economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems and the environment."

IWRM is based on the recognition that the various uses of water resources are interdependent: such as municipal and industrial water, irrigation, power generation, recreation, fisheries and ecosystems. According to the GWP, the IWRM approach promotes more coordinated development and management of land and water, surface water and groundwater, the river basin and its adjacent coastal and marine environment, and upstream and downstream interests. For policy-making and planning, taking an IRWM approach requires that[39]:

- water development and management takes into account the various uses of water and the range of people's water needs
- stakeholders are given a voice in water planning and management, with particular attention to securing the involvement of women and the poor
- policies and priorities consider water resources implications, including the two-way relationship between macroeconomic policies and water development, management, and use
- water-related decisions made at local and basin levels are along the lines of, or at least do not conflict with, the achievement of broader national objectives
- water planning and strategies are incorporated into broader social, economic, and environmental goals.

Common components of IWRM include the following[40]:

- **Main national instruments and other national strategies that may contribute to promoting IWRM** – these are laws, policies, strategies, action plans, and programmes that are aimed at introducing and promoting the IWRM approach in all aspects of economic life
- **Water resources development** – water resources need to be developed to maximise flexibility of response to the adverse effects of climate change. For examples, in areas with

[39] Global Water Partnership, at http://www.gwp.org/The-Challenge/What-is-IWRM/Key-IWRM-concepts

[40] As presented in: UN-Water (2008). Status Report on IWRM and Water Efficiency Plans for CSD16.

dwindling water resources, rain water harvesting could be promoted, whilst in areas subjected to flooding, water retention measures could be undertaken

- **Water use** – efficient in water use should be promoted. In areas where consumption is already low (such as Moldova, although official consumption rates do not include augmenting supply, for example by purchasing bottled water), water savings should come through reducing technical losses, in particular where large reductions in operating and maintenance costs can be realised

- **Monitoring, information management and dissemination** – information on water quality and quantity needs to be collected and kept up-to-date. This information should be made available to the public

- **Capacity development and enabling environment** – institutional reforms are required in terms of personnel, procedures, organisational structures, and information collection and management

- **Stakeholder participation** – stakeholders affected by future developments in the water sector need to be informed of the risks of climate change and be asked for their inputs in the decisions on how to use water resources and best adapt to climate change

- **Financing** – the cost of development and use of water resources should be reflected in the price of water. The opportunity costs of water scarcity should also be taken into account. The financing of investments – from national, foreign and user sources – needs to be considered. Targeted assistance should be used to support poorer segments of society pay for WSS services.

IWRM takes into account that water used by one sector can be recycled or reused for another sector. For example, treated wastewater can be used for irrigation of some crops or natural systems such as wetlands can be used to achieve certain treatment levels of wastewater and reintroduced into the environment, for example to re-charge groundwater or maintain environmental flow in rivers.

IWRM also means that different demands for water will be managed and coordinated. The relevant stakeholders for each of the main water users are identified and analysed, including domestic, commercial, institutional, and industrial water supply and sanitation, agriculture, power production, water storage, recreation, and for maintenance of healthy ecosystems. The line ministries for each of these uses, represented by the most relevant departments within them, need to coordinate their activities and when necessary to eliminate overlapping responsibilities. The management and coordination of different demands and allocation among them requires a participatory approach in which the priorities for the use of water resources are stated. When the amount of available water is not sufficient to allocated among the different uses, additional sources need to be identified.

IWRM-based water basin management plans in Moldova are considered incremental expenditures attributable to this climate change adaptation strategy.

Therefore, an expenditure of **650,000 EUR is assumed.**

Take climate change impacts into account in land-use and/or urban planning

Relevant laws and by-laws on land-use and urban planning need to be amended to consider the impacts of climate change on water resources. These should be undertaken within 2013 and as this is a normal part of government activities, no incremental expenditures are considered.

Develop and implement a country-wide flood management plan, including preventive measures

The European Investment Bank (EIB) at al will be providing support to the Republic of Moldova on development of a country-wide flood management plan and respective project for flood protection is in preparation. Discussions on the scope of the project and the specific measures are on-going. In all likelihood, however, the following measures/activities will be included in the project:

- Master Plan for flood prevention and protection
  - Hydraulic Modelling and preparation of Flood Hazard Maps
  - Flood Risk Assessment
  - Identification of measures for flood risk management
  - Development of Investment Programs
- Management and river monitoring system
  - GIS based River Management and Monitoring System
  - Capacity Building.

The inventory of existing facilities, involving data collection on existing flood defence infrastructure and its condition, as well as an overview map of existing flood defence infrastructure and investments for flood risk management are included in the EIB project. In terms of capacity development, it is expected that trainings in direct connection with the planned measures such as hydraulic modelling and risk assessment and set out of flood risk areas will be provided.

Complementary to the future EIB project, the climate change adaptation strategy focuses on the operation, maintenance and inspection of flood management facilities.

This measure is important to climate change adaptation in the WSS sector, but is not considered an incremental expenditure for this adaptation strategy given that the costs are included in the EIB-funded project. Therefore, no incremental expenditure is assumed under this measure.

Develop and implement a national plan to manage other natural hazards (such as droughts, extreme heat and frost, strong winds, landslides, etc.)

A national disaster risk management plan should be developed based on the assessment carried out under the activity "*Develop disaster and climate risk assessment system"* (Know the risks). While such a plan should be implemented regardless of the need for climate change adaptation, **an incremental expenditure of 200,000 EUR** is assumed above the normal costs of such a disaster risk management plan.

Improve and/or create flood warning systems in Prut and Dniester basins

Early flood warning systems are instruments to warn emergency services, local and central government as well as communities at risk to take effective action before the occurrence of a likely flood. Effective early flood warning is essential if local authorities and emergency services can undertake the necessary measures to mitigate the effects of a potential flood and to warn the population of a possible threat. Early flood warning systems serve to save lives, minimise flood damage to properties and reduce economic and social losses. This measure involves an analysis

of existing warning systems, identification of room for improvements and activities addressing the potential improvements.

While flooding is expected to increase in intensity, it is assumed that this measure is required in Moldova regardless of the effects of climate change; therefore, no incremental expenditure is assumed under this measure.

Coordinate hydro-meteorological monitoring, risk assessment and risk management activities in trans-boundary basins with neighbouring countries: Romania and Ukraine

The results of the activities for hydro-meteorological monitoring, risk assessment and risk management that pertain to the trans-boundary basins should be coordinated with Romania and Ukraine (with Ukraine for the Nistru River and with Romania and Ukraine for the Prut River).

While this is an important part of climate change adaptation in the WSS sector in Moldova, this activity needs to happen anyway; therefore, no incremental expenditures are assumed for this adaptation strategy.

Develop and implement Master Plans for WSS at national & territorial levels, taking into account available sources of water supply

The development of guidelines for master plans for WSS is considered in the revised WSS Sector Strategy, followed by development of the master plans themselves. With modifications (listed in Annex B, related to specifically taking into account climate change adaptation), the revised WSS Sector Strategy adequately covers master plans and no incremental expenditures are considered here. The timing of master plans is described and this work is budgeted in the revised Moldova's WSS Sector Strategy. No incremental expenditure is assumed under this measure.

Improve water use efficiency

Activities undertaken in this regard should be part of respective sectoral programmes and water demand management plans, foremost in the irrigation and WSS sectors, as well as in water-intensive industries. Inter alia, in WSS raion and local level water demand management plans should be mandated and prepared. The plans should cover in particular measures to reduce physical losses in water and sanitation facilities. These measures should include simple flow metering, leakage detection and rehabilitation works that account for 50% of existing losses. Technical trainings on leakage detection should also be offered. Water demand management is key to identifying measures and options that will reduce both the O&M costs and the need for new water supply and sanitation infrastructure for given service levels, in compliance with the overarching principles of EU water policy.

A budget of 400,000 EUR is assumed for the development of water demand management plans.

In other ways, efficiency of water use will follow from the reform of tariffs for water supply and sanitation. These reforms are considered part of the revised WSS Sector Strategy and no incremental expenditures are assumed with respect to climate change adaptation. Efficiency gains will also help reduce medium and long-term capital investment needs in water supply and sanitation infrastructure.

Integrate climate change impacts in building codes, and new construction rules/technological standards established for WSS specifically

The expected impacts of climate change on water resources and WSS infrastructure need to be integrated into building codes, construction rules, and technological standards. A team from the

Ministry of Regional Development and Construction of Moldova has been working on updating building codes, and new construction rules/technological standards. Their work should also take into consideration impacts on WSS specifically. As this is an on-going government effort, no incremental expenditures are assumed, provided that the current work can be modified to take into account climate change adaptation.

4. Make the best use of green infrastructures and alternative sources of water

These measures are intended to improve the resiliency of water resources by recharging groundwater sources, reusing water, and capturing rainwater. They all involve capital expenditures that should be based on studies and plans to identify the optimal interventions.

- Create water retention areas, flood control reservoirs/natural retention polders in areas at risk of floods
- Increase soil infiltration using wetlands, afforestation; avoid sealed surfaces in urban development
- Maintain natural flood plains for rivers where appropriate
- Combine artificial groundwater recharge, wastewater re-use, rainwater harvesting, where possible and feasible.

Each of these is discussed briefly below.

Create water retention areas, flood control reservoirs/natural retention polders in areas at risk of floods

Based on IWRM plans at the basin level and the country-wide flood management plan ("Manage the Risk"), the optimal investments for water retention, flood control reservoirs and natural retention polders can be identified and prioritised. Some of these investments will be explicitly due to the increased risks of water-related disaster due to climate change, while others should take place as part of normal disaster risk management. These measures will require incremental expenditures beyond that which would have otherwise been required. Until the hydro-meteorological monitoring system is improved and the IWRM plans and country-wide flood management plan have been prepared, however, it is not possible to prioritise such investments and determine the extent to which additional expenditures are required in order to adapt to climate change.

Increase soil infiltration using wetlands, afforestation; avoid sealed surfaces in urban development

Studies should be conducted on areas that can be re-forested, or existing forested areas, for the purpose of retaining stormwater and reducing erosion. In times of flood, such forested area can provide terrain for the waters to percolate into the soil or to drain out of the water basin over time without causing damage to residential and economic interests. In times of average rainfall, the forested areas can capture and retain water in order to reduce pollution and sediment loads into rivers. Since 2003, a World Bank-supported project has achieved restoration of over 20,300 hectares of these severely degraded lands by planting trees, thereby reducing erosion and increasing soil infiltration.

Consistent with integrated water resources management, stormwater – rainwater from roofs and impermeable areas – can be used to recharge groundwater resources after some basic sand filtration in order to maintain the ability of the soil and underlying structures to accept the infiltration.

Stormwater can be collected and then pumped to recharge areas on an alternating basis (for example, 10 days wet and 20 days dry) in order for the soil to recover its biological cleaning capacity and to reduce the number of insects.

The costs and benefits of developing this infrastructure in cities and larger towns, as well as in rural areas where groundwater is a viable source of drinking water, should be explored.

The use of sealed surfaces in urban areas should also be limited as practicable in order to avoid high flows into river courses and to enable water to percolate into the ground through retention areas.

Such interventions will require incremental expenditures beyond that which would have otherwise been required. Until sound hydro-meteorological monitoring system is in place and the IWRM plans and country-wide flood management plan have been prepared, however, it is not possible to prioritise such investments and determine the extent to which additional expenditures are required in order to adapt to climate change. Indeed, the use of natural water retention needs to be optimised with more capital-intensive investments such as water retention reservoirs and polders.

Maintain natural flood plains for rivers where appropriate

Rivers should have sufficient space for flooding outside of important settled areas or areas of economic significance. The costs and benefits of turning over some agricultural lands to natural flood plains, as well as the opportunity costs of maintaining existing natural flood plains versus their development, should be carefully explored. Until sound hydro-meteorological monitoring system is in place and the IWRM plans and country-wide flood management plan have been prepared, however, it is not possible to prioritise such interventions and determine the extent to which additional expenditures are required in order to adapt to climate change. Indeed, the use of natural water retention and re-establishment/maintenance of flood plains need to be optimised with more capital-intensive investments such as water retention reservoirs and polders.

Combine artificial groundwater recharge, wastewater re-use, rainwater harvesting, where possible and feasible

The collection and use of rainwater for gardening, irrigation, and sanitation are well-known, including in Moldova. The safety of use of untreated rainwater for human consumption, however, is not recommendable without further research on the water quality in Moldova. Contaminants in rainwater range from debris, to volatile organic chemicals, synthetic organic chemicals, metals, and microbiological contaminants. A study should be conducted on ways to support and guide the harvesting of rainwater for non-potable and potable use. In particular, the treatment and pumping costs of rainwater for potable use should be explored and guidelines issued not only for its use in piped water supply, but also in individual homes and apartment blocks.

An incremental expenditure is required to understand this issue fully. Therefore, a **one-time study with a budget of 50,000 EUR is assumed**.

5. Fix and adapt conventional water infrastructures

These measures involve infrastructure investments, many of which first need to be studied in detailed to determine their feasibility, compliance with WSS sector objectives,

- Protect most vulnerable villages fully dependant on shallow wells from drought by shifting to more reliable sources of water (surface water or deep boreholes/confined aquifers).
- Improve wastewater infrastructure capacity - focus on low-cost options in rural areas (e.g. septic tanks and EcoSan toilets), while suburban areas of big cities could be connected to centralised sewerage systems operated by *apacanals* (urban water utilities)
- Adapt the design of dikes and dams for flood protection, rehabilitate existing and build needed additional dikes and dams; this should be part of the future national plan for flood management
- Improve the operation and maintenance of existing flood management facilities (dikes, dams)
- Build intercepting collector drainage downhill of villages in landslide-prone areas
- Consider rehabilitation of existing and building new sewerage systems for collecting and safe disposal of storm waters in cities, to reduce the risk of regular flash flooding during torrential rains
- Protect existing and properly functioning water supply and wastewater facilities against flooding and direct impact of increased river flows (water intake facilities, pumping stations/treatment plants)
- Upgrade the performance of existing water treatment plants and wastewater collection and treatment infrastructure in Moldova (e.g., installation of pre-sedimentation pond or river bank filters for pre-treatment; aeration facilities for ammonium oxidation).

These measures are discussed briefly below.

Protect most vulnerable villages fully dependant on shallow wells from drought by shifting to more reliable sources of water (surface water or deep boreholes/confined aquifers).

Recent droughts have proved that villages where shallow wells are the main source of water supply are most vulnerable to drought. A key protection measure for such villages would be shifting to more reliable sources of water (surface water or deep boreholes).

Priority investments of 3.8 million EUR have been identified in the climate change adaptation strategy (see section 2.2.1 for detail).

Improve wastewater infrastructure capacity

Improvement of wastewater infrastructure capacity should focus on low-cost options in rural areas (e.g. septic tanks and EcoSan toilets), while suburban areas of big cities could be connected to centralise sewerage systems operated by *apacanals* (urban water utilities). The optimal set of investments should be determined after inventories of existing facilities and vulnerable water resources have been conducted and regional master plans developed. The revised WSS Sector Strategy covers the preparation of master plans and feasibility studies.

Regarding sanitation, a priority adaptation measure, driven also by the need substantially to reduce environmental and health risks by improving hygiene conditions, would be the implementation of

such low-cost options as Ecosan toilets or – where reliable piped water supply is available – septic tanks in all kindergartens, schools and other public buildings in rural areas.

Based on ApaSan project data, **the total estimated incremental cost of adaptation in the sanitation sector is estimated at 6.45 million EUR** (see section 2.2.1 for detail).

Adapt the design of dikes and dams for flood protection, rehabilitate existing and build needed additional dikes and dams

Appropriate measures should be identified as part of the future national plan for flood management. Until this is prepared, it is not possible to identify incremental expenditures in this regard.

Improve the operation and maintenance of existing flood management facilities

Appropriate measures should be identified as part of the future national plan for flood management. Until this is prepared, it is not possible to identify incremental expenditures in this regard, though it is expected that improvements in dikes and dams would be necessary regardless of the need for climate change adaptation of the WSS sector.

Build intercepting collector drainage downhill of villages in landslide-prone areas

Appropriate measures should be identified as part of the future national plan for flood management and the disaster risk management plan. Until these are prepared, it is not possible to identify incremental expenditures in this regard, though it is expected that such construction would be necessary regardless of the need for climate change adaptation of the WSS sector.

Consider rehabilitation of existing and construction of new sewerage systems for storm water

The optimal set of investments should be determined after inventories of existing facilities and vulnerable water resources have been conducted and regional master plans developed. The revised WSS Sector Strategy covers the preparation of master plans and feasibility studies. Natural storm water retention should be preferred where feasible to piped removal and disposal into rivers in order to reduce the risk of regular flash flooding during torrential rains. Therefore no incremental expenditures are assumed in this strategy.

Protect existing and properly functioning water supply and wastewater facilities against flooding and direct impact of increased river flows

The optimal set of investments should be determined after inventories of existing water intake facilities, pumping stations, treatment plants, and vulnerable water resources have been conducted and regional master plans developed. The revised WSS Sector Strategy covers the preparation of master plans and feasibility studies.

Upgrade the performance of existing water treatment plants and wastewater collection and treatment infrastructure in Moldova

The optimal set of investments should be determined after inventories of existing water treatment, wastewater collection, and wastewater treatment facilities have been conducted and regional master plans developed. The revised WSS Sector Strategy covers the preparation of master plans and feasibility studies. The installation of pre-sedimentation pond or river bank filters for pre-treatment; aeration facilities for ammonium oxidation should be considered.

6. Make best use of economic instruments and other regulatory instruments

Economic and regulatory instruments should be mobilised in order for water use to be directed toward its best use that promotes efficiency and equity.

- Put in place instruments (e.g. appropriate tariff system complemented by sound metering) that can influence water demand, taking into account affordability constraints
- Set sustainable water abstraction limits
- Define water rights in a flexible way: e.g. by adopting two sets of water allocation rules: one for normal and another for emergency situation
- Consider flood insurance schemes – e.g. obligatory insurance of property in flood and landslide-prone areas

Each of these is discussed briefly below.

Put in place instruments (e.g. appropriate tariff system complemented by sound metering) that can influence water demand, taking into account affordability constraints

As detailed in many sources, water consumption in Moldova is already quite low. Water consumption in Chisinau is estimated at 136 litre per capita per day (lcd), whilst for Bălţi this figure is 53 lcd, for other towns 40.4 lcd and villages at 25-25 lcd depending on the season. A 2012 macro and micro-affordability analysis of WSS Services[41] estimated urban household consumption at 100 lcd, rural areas at 70 lcd, and overall for the country at 90 lcd.

Given that studies[42] have shown that the ability of households to pay for WSS services is fully absorbed by water supply services alone and that adding wastewater collection and treatment services to piped water supply would more than double costs, consumption rates on levels seen in Western Europe (120 lcd) are not affordable for rural and sub-urban population. In fact, only when consumption is much lower (45 lcd) in rural area is a water supply system and simplified wastewater treatment system (such as a septic tank) are WSS services affordable.

Disposable income per person and per family[43] shows that in urban areas, 33.9% of population has to limit water consumption due to affordability constraints, while in rural areas, consumption below even 45 litres per person per day would be a problem for 73.5% of population. This is indeed observed in Moldova. In rural areas, if a full WSS system is built (piped water supply, wastewater services), a cost recovery tariff will be a problem for the majority of population; the population will cope, among others, by lowering water consumption. Lower water consumption in turn increases the unit costs of service provision and leads to technological problems, especially for centralized wastewater systems: blockages will occur in the sewage network, while the WWTP will not be fully operational due to unused capacity.

[41] Technical Assistance for the Implementation of Sector Policy Support Programme in the Water Sector (TA Water SPSP - EuropeAid/130872/C/SER/MD Contract 2011/270-593) Technical Report No 7 (TR7-C3) Macro- & Micro-Affordability of WSS Services (Final) 26 / June / 2012.

[42] See “Viable Business Models for Sanitation in Small Towns and Rural Settlements in Moldova” Task 3 Report under this OECD project

[43] according to "Aspects regarding the living standards of population in 2010, National Bureau of Statistics of the Republic of Moldova"

Thus, it can be said that the current tariff regime discourages water consumption. Lower consumptions lead to higher unit operating costs, poor cost recovery, and deteriorating infrastructure. For this reason, future WSS systems need to focus foremost on being as inexpensive to operate as possible, while maintaining treatment standards.

Operational savings, however, can be achieved through the reduction in non-revenue water, both technical and administrative. Technical water losses can be reduced through leakage detection and repair, whilst administrative losses can be reduced through physical inspection of water meters and collecting on customer bills.

The revised WSS Sector Strategy and its Action Plan (with modifications recommended in Annex B) adequately cover the establishment of tariffs, as well as improved metering, to influence water consumption, while taking into account affordability constraints. Therefore, no incremental expenditures are considered under this adaptation strategy.

Set sustainable water abstraction limits for both regular and water-stressed periods

Water abstraction limits can be set based on data obtained from the hydro-meteorological monitoring system, as well as the information obtained from the conducted inventories of water resources and WSS infrastructure. Limits are set and approved as part of government activities and therefore, no cost is considered. This is an on-going activity, as limits can be set and removed as necessary depending on prevailing conditions. Economic theory indicates, however, that water pricing, including scarcity surcharges, is a more effective way of limiting water consumption (and therefore water abstraction). Until the affordability of WSS services improves in Moldova, however, such economic instruments may not be feasible and such command and control measures may be necessary. Setting water abstraction limit is a routing responsibility of the Ministry of Environment. Therefore, no incremental expenditures are assumed for this adaptation strategy.

Define water rights in a flexible way: e.g. by adopting two sets of water allocation rules: for normal situation and for emergency situations

Water allocation in times of emergencies, in particular floods and droughts, should differ from allocation during normal periods. Allocation rules need to be developed by the Government of Moldova. In addition, water scarcity pricing should be introduced in order to provide incentives for efficiency in water use and allocating it toward its most economically efficient use. The Government of Moldova should undertake the appropriate studies to enable these changes. As this is a routing work of the government, no incremental expenditures are assumed..

Consider flood insurance schemes – e.g. obligatory insurance of property in flood and landslide-prone areas

Flood insurance could be considered for sharing risk due to climate and weather variability. If flood insurance policies are designed correctly, they can reduce exposure and vulnerability to risk and facilitate adaptation to climate change, by discouraging construction in high-risk areas through high-risk premiums. Conversely, premium discounts can be awarded for risk reduction. In many countries, however, private coverage is not available and even when it is, the national government functions as an insurer of last resort. Instituting private flood insurance, without public reinsurance, exists in the United Kingdom.

In Moldova, however, flood insurance is likely to prove too expensive for property owners and land-use and/or urban planning regulations would be more effective in reducing flood risk. To make flood insurance more affordable, the GoM could consider recusing property tax rates for the

immovable property in flood-prone areas which was insured against the risk of flood and ground water flooding, with sufficient coverage. If flood insurance is used, the national government should anyway discourage settlement and development in high-risk areas (e.g. in so called “red zone”), by signalling that it will not function as an insurer of last resort if settlements, production facilities or housing units are built in areas designated as high flood risk. Flood insurance should be explored further before implementation and the private sector should be involved in this study.

The following table summarises the correspondence between the measures envisaged in the Adaptation Strategy and those discussed in the Task 1 Report (Part III, chapter 2).

Table 3 Correspondence of measures in the Adaptation Strategy with those in Task 1 Report

Name of measure in Adaptation Strategy	Corresponding measure in Task 1 Report
Know the risks	
• Improve hydro-meteorological monitoring system	AG-2.1. Improve hydro-meteorological monitoring system in Moldova
• Develop disaster and climate risk assessment system	AG-2.2 Develop disaster and climate risk assessment system, as a basis for urban and infrastructure planning
• Set up a national centre for weather and water-related disasters preparedness, risk assessment, and management	AG-2.3 Upgrade of existing disaster management structures
• Conduct inventories of current conditions of water and sanitation infrastructure	AW-2.1: Conduct inventory of relevant localities with WTP and assessment of functional capability and performance AG-3.1: Inventory and improve the management of existing facilities: water reservoirs, dams and dykes …
Cap the risks	
• Raise public awareness for water conservation and water protection behaviour	AG-1.4: Improve water use efficiency, by developing plans for water demand management, raising public awareness, etc.
Manage the risks	
• Develop and implement IWRM plans at basin level, while factoring in climate change	AG-1.1: Implement IWRM and develop basin plans
• Take climate change impacts into account in land-use and/or urban planning	AW-1.4: Ensure enforcement of design and construction norms for pipelines, to protect them from extreme winter temperatures AG-2.5: Integrate climate change impacts in building and construction codes, new construction rules and technical standards established specifically for WSS, as well as in land-use and urban planning
• Develop and implement a country-wide flood management plan, including preventive measures	AG-3.2: Develop and implement a country wide flood management plan
• Develop and implement a national plan to manage other natural hazards	AG-3.3: Develop and implement a national plan of managing other natural hazards
• Improve and/or create flood warning systems in Prut and Dniester basins	AG-2.3: Upgrade of existing disaster management infrastructures for weather and water related disasters preparedness
• Coordinate hydro-meteorological monitoring, risk assessment and risk	AG-2.4 Coordinate hydro-meteorological monitoring, risk assessment and risk management activities in trans-boundary

Name of measure in Adaptation Strategy	Corresponding measure in Task 1 Report
management activities in trans-boundary basins with neighbouring countries: Romania and Ukraine	basins with neighbouring countries: Romania and Ukraine
• Develop and implement Master Plans for WSS at national & territorial levels, taking into account available sources of water supply	AG-1.2: Develop Master plans for WSS
• Improve water use efficiency	AG-1.4: Improve water use efficiency, by developing plans for water demand management, raising public awareness, etc. AW 3: Implement water demand management
• Integrate climate change impacts in building codes, and new construction rules/technological standards	AG-2.5: Integrate climate change impacts in building and construction codes, new construction rules and technical standards established specifically for WSS, as well as in land-use and urban planning
Make the best use of green infrastructures and alternative sources of water	AW-3.2: Encourage use of alternative water sources AG 4: Promote water retention measures, explore low cost options for reducing the risks
Fix and adapt conventional water infrastructures	AW-1.1: Protect water intake facilities from flooding AW-1.2: Protect pumping stations/treatment plants or other facilities potentially exposed to flooding AW-1.3: Ensure reservation of electricity supply sources for WSS facilities, especially in rural areas AW-2.2: Identify upgrading potential and develop feasibility studies AW-2.3: Increase local capacity in project development, fund raising, and implementation AW-2.4: Ensure proper operation and maintenance of treatment facilities AW-3.3: Systemically monitor and reduce leakages and commercial water losses AW 4-1: Shift from shallow wells to more reliable sources of water supply, such as surface water and confined aquifers - in villages dependant on shallow wells AW 4-2: Develop rural sanitation systems, focusing on low cost options (e.g. septic tanks and EcoSan toilets) AW 4-3: Build intercepting collector drainage downhill villages in landslide prone areas AW 4-4: Consider rehabilitation of existing and building new sewerage systems for the collection and safe disposal of storm waters in cities
Make best use of economic instruments and other regulatory instruments	AG-1.3: Set and enforce sustainable water abstraction limits and introduce flexible water allocation rules. AG-1.5: Make the best use of economic instruments and other regulatory instruments for IWRM AW-3.1: Put in place mechanisms that can influence water demand, such as policy-relevant tariff systems, complemented by appropriate metering

The following table summarises the timing and incremental cost (due to climate change adaptation, above what would normally be required) for the various measures

Table 4 Overview of Adaptation Measures for WSS in Moldova – Know the Risks

Measure	Target Date for Completion	Indicative Incremental Budget (million EUR)	Type of Expenditure (one-time, annual, etc.)	Expected outcome
Total "Know the Risk"		**0.900**		
Improve hydro-meteorological monitoring system	2013-2014	-	One-time	Hydro-meteorological monitoring system capable of providing robust data for decision-making and prioritisation of investments
Develop disaster and climate risk assessment system	2013-2014	-	One-time	Capacity development in disaster risk management (World Bank project)
Set up a national centre for weather and water-related disasters preparedness, risk assessment, and management	2015	-	One-time	National centre established
Conduct inventories of current conditions of water and sanitation infrastructure	2013-2014	0.900	One-time	Inventory of localities without safe access to water supply, sanitation, and current conditions of WSS sector infrastructure

Table 5 Overview of Adaptation Measures for WSS in Moldova – Cap the Risks

Measure	Target Date for Completion	Indicative Budget (million EUR)	Type of Expenditure (one-time, annual, etc.)	Expected outcome
Total "Cap the Risk"				
• *Raise public awareness for water conservation and water protection behaviour* • *Inform populations about water-related risks and the potential impacts of climate change* • *Assess the level of security people are willing to reach; inform them about the costs and constraints associated with alternative levels of security*	2013-2014	-	On-going	- Agreement on acceptable levels of risks associated with climate change achieved through democratic procedures and based on both evidences and economic and social values of Moldova; - Improved behaviour of economic agents regarding water conservation and water protection

Table 6 Overview of Adaptation Measures for WSS in Moldova – Manage the Risks

Measure	Target Date for Completion	Indicative Budget (million EUR)	Type of Expenditure (one-time, annual, etc.)	Expected outcome
Total "Manage the Risk"		**1.250**		
Develop and implement IWRM plans at basin level, while factoring in climate change	2013-2015	0.650	One-time	Basin level IWRM plans
Develop and implement a country-wide flood management plan, including preventive measures	2013-2015	-	One-time	National flood management plan (part of EIB project)

Measure	Target Date for Completion	Indicative Budget (million EUR)	Type of Expenditure (one-time, annual, etc.)	Expected outcome
Develop and implement a national plan to manage other natural hazards (such as droughts, extreme heat and frost, strong winds, landslides, etc.)	2014-2015	0.200	One-time	National Disaster Risk Management Plan
Improve and/or create flood warning systems in Prut and Dniester basins	2013-2017 (and beyond)	-	One-time	As above
Improve water use efficiency	2013-2014	0.400	One-time	Water demand management plans developed
Integrate climate change impacts in building codes, and new construction rules/technological standards established for WSS specifically	2013-2016	-	One-time	Building codes, construction rules and technological standards for WSS adapted for climate change adaptation
Take climate change impacts into account in land-use and/or urban planning	2013	-	One-time	Amendments to relevant legislation
Coordinate hydro-meteorological monitoring, risk assessment and risk management activities in trans-boundary basins with neighbouring countries: Romania and Ukraine	2013-	-	Recurring	On-going coordination

Table 7 Overview of Adaptation Measures for WSS in Moldova WSS – Green infrastructures

Measure	Target Date for Completion	Indicative Budget (1000 EUR)	Type of Expenditure (one-time, annual, etc.)	Expected outcome
Total: "Best use of green infrastructures and alternative sources of water"		**50**		
Create water retention areas, flood control reservoirs/natural retention polders in areas at risk of flood	2013-2017 (and beyond)	-	Recurring	Prioritised investments in water retention using more capital intensive investments
Increase soil infiltration using wetlands, afforestation; avoid sealed surfaces in urban development	2013-2017 (and beyond)	-	Recurring	Prioritised investments in soil infiltration and afforestation
Maintain natural flood plains for rivers where appropriate	2013-2017 (and beyond)	-	Recurring	Prioritised investments in establishment/re-establishment of natural flood plains
Combine artificial groundwater recharge, wastewater re-use, rainwater harvesting, where possible and feasible	2013; and beyond	50	one-time; recurring investments	Study on feasibility of rainwater harvesting and guidelines and incentives for its use

Table 8 Overview of Adaptation Measures for WSS in Moldova – Fix and adapt conventional water infrastructure

Measure	Target Date for Completion	Indicative Budget (1000 EUR)	Type of Expenditure (one-time, annual, etc.)	Expected outcome
Total: "Fix and adapt conventional water infrastructure"		**10,250**		
Protect most vulnerable villages fully dependant on shallow wells from drought by shifting to more reliable sources of water	2013-2017 (and beyond)	3,800	On-going investments	Priority investments in water supply related to climate change adaptation; Additional investments under this measure should be part of Water Demand Management plans in both: WSS and irrigation sectors
Improve wastewater infrastructure capacity - focus on low-cost options in rural areas (e.g. septic tanks and EcoSan toilets), while suburban areas of big cities could be connected to centralised sewerage systems operated by apacanals (urban water utilities)	2013-2017 (and beyond)	6,450	On-going investments	Priority investments in sanitation related to climate change adaptation
Adapt the design of dikes and dams for flood protection, rehabilitate existing and build needed additional dikes and dams; this should be part of the future national plan for flood management	2013-2017 (and beyond)	-	On-going investments	Priority investments identified as part of national plan for flood management
Improve the operation and maintenance of existing flood management facilities (dikes, dams)	2013-2017 (and beyond)	-	On-going investments	Priority investments identified as part of national plan for flood management
Build intercepting collector drainage downhill of villages in landslide-prone areas	2013-2017 (and beyond)	-	On-going investments	Appropriate measures should be identified as part of the future national plan for flood management and the disaster risk management plan

Measure	Target Date for Completion	Indicative Budget (1000 EUR)	Type of Expenditure (one-time, annual, etc.)	Expected outcome
Consider rehabilitation of existing and building new sewerage systems for collecting and safe disposal of storm waters in cities, to reduce the risk of regular flash flooding during torrential rains	2013-2017 (and beyond)	-	On-going investments	The optimal set of investments should be determined after inventories of existing facilities and vulnerable water resources have been conducted and regional master plans developed. The
Protect existing and properly functioning water supply and wastewater facilities against flooding and direct impact of increased river flows (water intake facilities, pumping stations/treatment plants)	2013-2017 (and beyond)	-	On-going investments	The optimal set of investments should be determined after inventories of existing water intake facilities, pumping stations, treatment plants, and vulnerable water resources have been conducted and regional master plans developed.
Upgrade the performance of existing water treatment plants and wastewater collection and treatment infrastructure in Moldova (e.g., installation of pre-sedimentation pond or river bank filters for pre-treatment; aeration facilities for ammonium oxidation).	2013-2017 (and beyond)	-	On-going investments	The optimal set of investments should be determined after inventories of existing water treatment, wastewater collection, and wastewater treatment facilities have been conducted and regional master plans developed.

Table 9 Overview of Adaptation Measures for WSS in Moldova – Best Use of Economic and Regulatory Instruments

Measure	Target Date for Completion	Indicative Budget (1000 EUR)	Type of Expenditure (one-time, annual, etc.)	Expected outcome
Total: Best use of economic instruments		-		
Put in place instruments (e.g. appropriate tariff system complemented by sound metering) that can influence water demand, taking into account affordability constraints	2013-2014	-	Recurring	Tariff system being reviewed under WSS Sector Strategy
Set sustainable water abstraction limits for both regular and water-stressed periods	2015	-	On-going	Water abstraction limits set as required based on robust hydro-meteorological data
Define water rights in a flexible way: e.g. by adopting two sets of water allocation rules: for normal situation and for emergency situations	2014	-	one-time	Flexible rules and guidelines for water allocation in times of emergency
Consider flood insurance schemes – e.g. obligatory insurance of property in flood and landslide-prone areas	2014	-	one-time	Guidelines for use of flood insurance schemes

Annex B: Integration of priority adaptation measures into the mid-term Action plan for implementing the WSS sector strategy (proposed adjustments to the plan)

The mid-term Action Plan for implementing the revised WSS Sector Strategy (see Annex 12 to the Strategy) comprises a table with actions, timeframe for implementation, estimated costs, responsible unit, etc. As such, large amounts of text cannot be added without compromising readability of the Action Plan. Therefore, a note should be attached to the Action Plan that explicitly identifies climate change adaptation as a priority that needs to be included in key activities. The following is a proposed text:

"Several of the activities specified in the Action Plan have can have implications for adaptation of WSS to climate change. Therefore, it should be understood that the following activities should explicitly take adaptation into account:

- 2.3.1.4 Get the law on Public Services for WSS approved by the Government and Parliament – the law should contain a clause in the chapter on purpose and objectives that adaptation of public sector assets (including water supply and sanitation) to climate change is a stated priority
- 2.3.1.5 Revise the text of the law on local public administration to allow the aggregation of water company – the clauses enabling the aggregation of water companies should contain language that adaptation of water supply and sanitation assets to climate change be used as a criterion for determining the optimal clustering of service areas
- 2.3.1.7 Revise the text of laws on municipal services to enable regional operating companies in the country – the clauses enabling the establishment of regional operating companies should contain language that adaptation of water supply and sanitation assets to climate change be a joint objective and obligation (with the Government) of these companies
- 2.3.1.8 Get the revised laws on municipal services approved by the Government and the Parliament – the law should contain a clause in the chapter on purpose and objectives that adaptation of public sector assets (including water supply and sanitation) to climate change is a stated priority
- 2.3.2.1 Establish a planning and programming unit for WSS investment by MoEn with 4 dedicated full time staff – the unit's objectives and responsibilities should include ensuring adaptation of WSS infrastructure to climate change
- 2.3.2.2 Establish a Task Force (MoEn, MoRDC, MoEco, MLA, others) to design the guidance texts for the legal setting of Regional Operating Companies – the guidance texts developed by the Task Force should explicitly state that Regional Operating Companies have an obligation to include climate change adaptation in their planning and investment activities
- 2.3.3.1 Get the revised national WSS strategy approved by the Government – the WSS Strategy should be modified to include the text from the WSS sector adaptation strategy (see Annex C of this report)

- 2.3.3.2 Get the guidance on content of a Master Plan (MP) including rules and procedures for approval of MP documents approved as a Ministerial or Governmental order – the guidance document should explicitly contain a requirement to consider climate change adaptation in master plans, in particular in developing the optimal set of WSS investments to meet service level targets that should include resiliency of water supply, protection of water sources from floods and contamination from wastewater and other threats, and development of rural sanitation
- 2.3.3.3 Develop Guidance Documentation on the structure and content of a WSS Project Feasibility Study (FS) – the guidance document should explicitly contain a requirement that feasibility studies consider climate change adaptation, in particular in describing how the proposed project meets adaptation objectives in the areas of resiliency of water supply, protection of water sources from floods and contamination from wastewater and other threats, and development of rural sanitation
- 2.3.3.5 Establish a Task Force (MoEn, MoRDC, GIZ, SDC, ADA, others) to prioritize the raional WSS MPs and FSs to be developed in the country – among its objectives, the Task Force should be required to consider climate change adaptation in the rational MPs and FSs
- 2.3.3.6 Develop raional WSS MPs in priority raions of the country – the MPs should consider climate change adaptation, in particular in developing the optimal set of WSS investments to meet service level targets that should include resiliency of water supply, protection of water sources from floods and contamination from wastewater and other threats, and development of rural sanitation
- 2.3.3.7 Develop major WSS infrastructure Projects Feasibility Studies (FSs) in raions with approved WSS MPs – the FSs should demonstrate how the project addresses adaptation objectives in the areas of resiliency of water supply, protection of water sources from floods and contamination from wastewater and other threats, and development of rural sanitation. Project documentation should explicitly address how the proposed project contributes to adaptation to climate change
- 2.3.3.8 Develop minor WSS infrastructure Projects (decentralized solution for rural villages) – project documentation should explicitly address how the proposed project contributes to adaptation to climate change
- 2.3.4.1 Establish a Task Force (MoEn, ANRE, MoH)) to define performance indicators of Water Operating Companies also to be considered to promote PPP models – the performance indicators should include those specifically measuring resiliency of water and sanitation infrastructure to climate change, for example: percentage of population in the service area using water from shallow wells that are vulnerable to drought and/or contamination
- 2.3.4.3 Establish a Task Force (MoEn, MoRDC, ANRE, AMAC, MLA, MoF, others to define incentives and rules and procedures to foster the aggregation of Water Operating Companies – climate change adaptation should explicitly be among the criteria to be considered when determining the optimal aggregation of WOCs

- 2.3.4.5 Support the aggregation of Water Operating Companies (WOC) into Regional Operating Companies (ROC) – climate change adaptation should explicitly be among the criteria to be considered when determining the optimal aggregation of WOCs into ROCs
- 2.3.4.8 Develop Water Safety Plan by Water Operating Companies – water safety plans should include climate change adaptation measures.
- 2.3.5.1 Establish a Task Force (MoEn, MoRDC, MoF) to develop a Yearly Multiannual WSS Operational Plan for the Mobilization of Funding Resources for WSS planning and investment dovetailing into the MTBF process – the Task Force will consider climate change adaptation of WSS and integrate it into the MTBF process
- 2.3.5.3 Establish a Task Force (MoEn, ANRE) to define tariff and business planning policy for Water Utility Companies – the Task Force should consider including the possibility of allowing water scarcity pricing during periods of drought and define rules and procedures for its use
- 2.3.6.1 Establish a Task Force (MoEn, MoRDC, MoF, Donor Projects PIUs, others) to agree on reporting dataset requirement and procedures for reporting , scoring and prioritizing projects into the WSS MIS Project Pipeline for future project being planned and project construction progress reporting for projects under construction – the Task Force should consider the results of the inventory of water resources and WSS assets (as part of the WSS climate change adaptation measures) in defining the project pipeline. One of the primary objectives of the project pipeline should be to increase the resiliency of water resources and WSS sector assets to climate change.
- 2.3.7.1 Establish a Task Force (MoEn, MoRDC, MoF, Donor Projects PIUs, others) to agree on reporting indicators and reporting format and procedures for monitoring and evaluation of the implementation of the revised WSS investment strategy – the reporting indicators should include progress on climate change adaptation. The WSS investment strategy should consider climate change adaptation of the sector in setting investment priorities.
- 2.3.7.3 Provide Yearly Report on the Progress of the implementation of the revised WSS strategy using the agreed indicators – an indicator of climate change adaptation should be included and reported, for example percentage of population in the service area using water from shallow wells that are vulnerable to drought and/or contamination."

In addition, the following activity is recommended for inclusion in the mid-term Action Plan for implementing the revised Moldova's WSS Sector Strategy:

- 2.3.3.0 Conduct inventories of current conditions of water resources, water and sanitation infrastructure in order to inform decisions on how best to cap and manage risks of climate change to WSS and guide investment decisions. **Budget: 900 thousand EUR**

Annex C: Proposed new text of Section 4.3.4 in the revised Moldova's WSS sector strategy

"Section 4.3.4: Adapting WSS sector to climate and water-related disasters exacerbated by climate change

Climate and water-related risks and the vulnerability of Moldova to them

The overarching objective of the National Climate Change Adaptation Strategy (NCCAS) of the Republic of Moldova is:

> *To ensure that the Republic of Moldova's social and economic development is resilient to the impacts of climate change, by establishing a strong enabling environment and clear direction for an effective and coherent climate change adaptation process to take place across all relevant sectors.*

The NCCAS as well as studies recently implemented by a number of international institutions (World Bank, UNDP, UNECE, OECD et al) have revealed significant risks of climate and water–related natural hazards - they are already high and projections predict that they will only grow due to climate change.

Key climate and water-related impacts on water resources and the WSS infrastructure in Moldova, are as follows[44]:

- **Precipitation** – while overall precipitation is expected to remain close to past figures, the variability of this precipitation over the year is expected to increase dramatically, contributing to floods and droughts.
- **Surface water quantity** – climate change models conclude average run-offs of the surface water, including the rivers Prut and Dniester, will decrease by 2020 in average by 13% or even 16 – 20%[45] (depending on the modelling scenarios), while peak flows will increase, thus increasing the risks of floods and droughts.
- **Decreasing annual surface water runoffs and reduced ground water recharge** combined with the ambitious target of national economic development will lead to water scarcity in the 2020s or in the 2030s (when considering both surface and ground water) [46]
- **Surface water quality** – during droughts, surface water quality is expected to decline (involving decreased concentrations of dissolved oxygen and increased concentrations of N-ammonium etc.). During floods, the concentrations of suspended solids and sediments are expected to increase.
- **Shallow water** –some 50% of the population of Moldova use shallow wells as a main source of water supply. During droughts – for example, as seen in 2007 and 2012 – the water tables lower and many shallow wells dry out, threatening the security of water supply in affected villages.

[44] See report "Analyse selected adaptation measures and propose a feasible adaptation strategy for WSS" on Task 2 under the project: *"IMPROVING THE ENVIRONMENTAL QUALITY OF THE BLACK SEA THROUGH BETTER WASTE WATER TREATMENT & CLIMATE CHANGE ADAPTATION OF THE WATER SECTOR IN MOLDOVA", co*-sponsored by EC (DG ENV) and OECD/EAP Task Force.

[45] National Human Development Report. Climate Change in Moldova, 2009/2010

[46] ibid

- **WSS Sector infrastructure** – during floods, affected pumping stations stop operating and water mains can be damaged, capacity of water treatment plant are often exceeded and a switch to alternative and less reliable water resources is needed. Wells are often polluted by flash floods (e.g. region Hancesti during 2010 flood)

Main weather and water-related natural hazards to which Moldova and/or its WSS sector is most vulnerable are as follows:

- **Storms, windstorms and snow storms, torrential rain and hail:** according to World Bank estimations, Moldova is placed on the fifth place in the world among the countries which are most exposed to the risk of storms. In November 2000, a windstorm affected the livelihood of 2,600,000 people (more than 60% of total population) [47]. As interruptions in electricity supply to villages are amongst typical main damages produced by storms, especially in winter time when snow storms and rains sometimes result in heavy ice-loading on, and eventual breakages of, electricity grids, they threaten the reliability of water supply in villages using electric pumps for pumping water from deep boreholes – e.g. such "black outs" happened e.g. last December in some 150 villages, and in the whole northern Moldova in early 2000-ies. The problem is exacerbated by the fact that despite existing design and construction norms back-up power supply for WSS facilities (back-up power connection or generator) in rural areas is often absent;
- **Extreme summer and winter temperatures**: e.g. in summer 2012, an unfortunate combination of a prolonged *heat stress* (extreme temperatures) and a drought resulted in huge economic losses, mostly in agriculture, amounting to 1.25 billion USD [48] – equivalent of some 17% of country's 2011 GDP[49]. In WSS, extreme winter temperatures often damage water pipes placed on, or below but too near, the surface, as it is the case in some villages where water is supplied from local springs and streams. The problem is apparent even in Chisinau where some 30 km of distribution pipelines were frozen due to extreme temperatures in winter 2011/12;
- **Land slides:** due to this disaster, each year Moldova is loosing a number of rural houses, equivalent to a village or two. The problem is exacerbated by the fact that connection of rural households to piper water supply and natural gas is not accompanied by connection to piped sewerage or septic tanks, to collect and dispose of wastewater safely;
- **Floods**: e.g. "2008 floods cost the country about 120 million USD". The most recent floods in 2010 had an adverse economic impact at some 0.15% of GDP [50]; and finally,
- **Droughts:** "drought is becoming endemic in many parts of the country and is increasingly affecting rural livelihoods and development". E.g. in 2007 and 2012 it "resulted in losses of up to **70%** of major crops such as wheat, maize and sunflower" (NCCAS).

Vulnerability of Moldova and its WSS sector to droughts is very high indeed. E.g. according to a World Bank study, the 2007 drought affected a rural population of about 1.2 million persons in

[47] Moldova - Storm, rain and frost OCHA Situation Report No. 2, UN Office for the Coordination of Humanitarian Affairs, 2000

[48] World Bank, "Project Appraisal Document on a Proposed Credit to the Republic of Moldova for a Disaster and Climate Risk Management Project", July 6, 2010.

[49] Moldova's GDP: 7.003 billion USD, source: www.imf.org

[50] Post disaster Needs Assessment, Floods 2010, Gov. Republic of Moldova with support from EU, UN, World Bank

Moldova. 156 villages (some 300,000 people) were qualified as strongly affected, out of which 41 villages with 100,000 populations were the most affected by the 2007 drought. In such villages, the main or the only available source of water was shallow wells. In many cases, the source of water completely dried up[51]. A programme to help selected most affected villages was designed in 2008 but has not been yet implemented in the field. Unlike 2007, consequences of the sever 2012 drought on rural WSS were not assessed properly yet.

As rural population (whose income depends mostly on agriculture) amounts to some 60% of the Moldova's total population[52], indirectly, the aforesaid huge losses in agriculture during 2012 drought may have a strong negative impact on the ability of rural population to pay for water and sanitation, thus exacerbating the affordability problem highlighted in section 5.7 of this strategy.

Projections suggest that the risk of the climate and water-related hazards will further increase in the future due to climate change, with greater impact on water resources and the WSS Sector. Such impacts and the vulnerability of Moldova's WSS Sector to them necessitate a policy response to adapt the water supply and sanitation sector to climate change. The business as usual is not an option for Moldova.

Strategic measures to adapt the WSS sector in Moldova to the risks associated with climate change

Remaining uncertainties regarding the timing and scale of impacts are forcing decision-makers to focus on "no regret" measures (those that will bring multiple socio-economic and environmental benefits, including higher resilience to climate change), starting from low-cost ones[53]. Adaptation measures envisaged in this strategy are specifically intended to increase the resilience of WSS infrastructure in Moldova to floods, droughts, and extreme weather events. They follow the approach designed by the OECD (2013) and are delineated in the following groups:

Know the risks

Measures to help "know" the risk are necessary to close information gaps and increase awareness in the government and the public of climate change impacts and the risks they entail. Respective measures envisaged by this Strategy are as follows:

- Improve hydro-meteorological monitoring system to obtain timely and reliable data for the assessment and management of main risks of weather and water-related disasters
- Develop disaster and climate risk assessment system, as a basis for urban and infrastructure planning, especially in most vulnerable areas
- Upgrade of existing disaster management structures (e.g. the Civil Protection and Emergency Situations Service, CPEES) or set up a national center (and eventually local centres in Prut and Dniester basins) for weather and water related disasters preparedness, risk assessment, and management, in coordination with Ukraine and Romania, as appropriate.

[51] Drought Emergency Project, Rural Water Component Moldova 2007, World Bank 2007

[52] National Workshop on Implementing a National Disaster Observatory (NDO) and Systematic Inventory and Evaluation for Risk Assessment (SIERA) in Moldova, 2010, GRIP, UNDP, CPESS

[53] By minimal costs here we mean minimal annualised capital and O&M costs.

- Conduct inventories of current conditions of water and sanitation infrastructure in order to inform decisions on how best to cap and manage risks to WSS of climate change and guide investment decisions.

Inventories are necessary, as Moldova lacks data needed for risk assessment and management.

Cap the risks

"Capping the risk" calls for determining the acceptability and tolerability of a given risks associated with climate change. It is about making a political decision (through democratic procedures) on the acceptable levels of risks, while implementation of the decision made falls under the "manage the risk" category. The political decision should rely on both evidence- and values-based judgements and the Government of Moldova (GoM) will engage key stakeholders in decision-making. To engage and modify the behaviour of water users in Moldova the following measures are envisaged by this Strategy:

- Raise public awareness for water conservation and water protection behaviour
- Inform populations about water-related risks and the potential impacts of climate change
- Assess the level of security people are willing to reach; inform them about the costs and constraints associates with alternative levels of security

Manage the risk

Measures aimed at "managing the risk" aim at addressing institutional and regulatory barriers that may inhibit timely and efficient adaptation. Foremost, "no regrets" and "low regrets" options will be identified that are applicable in all plausible futures. To that end, the following measures are envisaged by this Strategy:

- Develop and implement IWRM plans at basin level, while factoring in climate change. IWRM plans should provide an acceptable level of security (see above) at affordable costs. They include measures to decrease vulnerability (e.g. banning new settlements in flood prone areas, making the best use of alternative sources of water, see below).
- Develop and implement a country-wide flood management plan, including preventive measures; adjust land use planning, building and construction codes to discourage activities and construction in flood prone areas;
- Develop and implement a national plan to manage other climate related natural hazards (such as droughts, extreme heat and frost, strong winds, landslides, etc.)
- Improve water use efficiency – related activities should be part of respective sectoral programmes and water demand management plans, foremost in the irrigation and WSS sectors, as well as in water-intensive industries
- Improve and/or create flood warning systems in Prut and Dniester basins
- Coordinate hydro-meteorological monitoring, risk assessment and risk management activities in trans-boundary basins with neighbouring countries: Romania and Ukraine.

Make the best use of green infrastructures and alternative sources of water

- Create water retention areas, flood control reservoirs/natural retention polders in areas at risk of floods
- Increase soil infiltration using wetlands, afforestation; avoid sealed surfaces in urban development

- Maintain natural flood plains for rivers where appropriate
- Combine artificial groundwater recharge, wastewater re-use, rainwater harvesting, where possible and feasible.

Fix and adapt conventional water infrastructures

- Protect most vulnerable villages fully dependant on shallow wells from drought by shifting to more reliable sources of water (surface water or deep boreholes/confined aquifers)
- Improve wastewater infrastructure capacity - focus on low-cost options in rural areas (e.g. septic tanks and EcoSan toilets), while suburban areas of big cities could be connected to centralised sewerage systems operated by *apacanals* (urban water utilities)
- Adapt the design of dikes and dams for flood protection; rehabilitate existing and build needed additional dikes and dams where other options (e.g. green infrastructure) cannot be applied; this should be part of the future national plan for flood management
- Improve the operation and maintenance of existing flood management facilities (dikes, dams)
- Build intercepting collector drainage downhill of villages in landslide-prone areas
- Consider rehabilitation of existing and building new sewerage systems for collecting and safe disposal of storm waters in cities, to reduce the risk of flash flooding during torrential rains
- Protect existing and properly functioning water supply and wastewater facilities against flooding and direct impacts of increased river flows (water intake facilities, pumping stations/treatment plants)
- Upgrade the performance of existing water treatment plants and wastewater collection and treatment infrastructure in Moldova (e.g., installation of pre-sedimentation pond or river bank filters for pre-treatment; aeration facilities for ammonium oxidation).

Make the best use of economic instruments and other regulatory instruments

- Put in place tariff systems complemented by appropriate metering that can curb water demand, taking into account affordability constraints
- Set sustainable water abstraction limits for both regular and water-stressed periods
- Define water rights in a flexible way: e.g. by adopting two sets of water allocation rules: one for normal and another for emergency situations - this can ensure that priority uses are served in case of scarcity
- Consider flood insurance schemes – e.g. obligatory insurance of immovable property in flood and landslide-prone areas – this provides a disincentive to build in such areas and takes some of the burden of the insurer of last resort from the public purse

These adaptation measures are fully consistent with the objectives of this Strategy, as well as with the aforesaid overarching objective set out in the NCCAS. They will be implemented in both the WSS sector and outside it.

Mid-term priority actions relevant for WSS are integrated in the *mid-term Action plan for the implementation of this strategy* (see Annex 12), where some of them are further translated into specific steps and/or individual measures."

Annex D: Summary of cross-fertilisation and synergies with other activities, projects and processes

Project Tasks	**Facilitation of …**	**Complementarily or Input to …**	**Links or Synergies with …**
	… the following ongoing projects/activities and processes:		
Tasks 1- 2	Ongoing policy discussions of climate change adaptation issues in Moldova	**NCCAS****, developed with support from **UNDP**	"**Dniester III floods and climate project**" sponsored by the **UNECE**
		EC-funded TA Water SPSP (section on adaptation in the revised Moldova's WSS Sector Strategy)	
		National Plan for Flood Protection (to be drafted with support from EIB *et al*) and a national plan for reducing risks of other natural hazards	
Task 3	**EC-funded Water SPSP****		
		EBRD project on regionalisation of water operating companies	Institutional component of the ApaSan project funded by **SDC**
		Regional development process: pilot testing some recommended business models in the frame of the ongoing regional development project funded by **GIZ *****	
	Inter-communal cooperation in Moldova (e.g. input to the 1st National conference on Inter-Municipal Cooperation (IMC) in 2012)		

* NCCAS stands for the National Climate Change Adaptation Strategy

** SPSP stands for the Sector Policy Support Programme (for the water sector in Moldova)

*** **Note**: The location(s) for pilot testing recommended business model(s) was identified in collaboration with **GIZ**: the **city of Cahul** was selected and for this very reason part of the effort during the "*reality check*" under Task 3 was performed in this specific location.

By February 2013, GIZ has supported the city of Cahul and 3 neighbouring rural communes (villages: Rosu, Manta, Crihana Veche) to expand water supply services to those villages. The physical connection has already been constructed and institutional setup is under preparation. Cahul and the 3 rural communes have issued local council resolutions and in the next month it is expected that the institutional and legal form of the service provider will be decided (now the municipal water utility (*ApaCanal*) in Cahul is a municipal enterprise)

There are also similar plans to expand and improve wastewater services under the same institutional setup. A feasibility study to further expanding WSS services to other villages surrounding the city of Cahul is under preparation. Similar approach is planned for the **town of Costesti** in Riscani rayon of Moldova, however as of February 2013 a feasibility study was only under an early stage of preparation.