Final publishable summary report of the WETwin project

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SEVENTH FRAMEWORK PROGRAMME

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Collaborative Project (Small or medium-scale focused research project)
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Acronym: WETwin
Full project title: Enhancing the role of wetlands in integrated water resources management for twinned river basins in EU, Africa and South-America in support of EU Water Initiatives

Contents

Executive summary

Although wetlands provide valuable ecosystem functions and services on both local and basin scales, they tend to be in degraded state worldwide. The WETwin project aimed at revealing the factors endangering wetlands at present and in the future, and at supporting the identification of strategies for their restoration and sustainable management. The project investigated 7 wetlands from Europe, Africa and South America as case studies.

Besides pressures like desiccation, pollution and encroachment, insufficient institutional capacity is also found responsible for the degradations. Institutional analyses showed that in most cases the institutional and legal framework for water and wetland policies is in place; the biggest bottleneck observed is the lack of implementation. In addition, there is a mix of new formal legislation and procedures, having been put in place recently, and informal instruments and practices from the past, which are still used by wetland managers and stakeholders. Thus, wetlands require improved institutional capacity with the overall objective to bring the degradation to a halt.

Model-based vulnerability assessments proved that degradation of wetlands will continue in the future, bringing them to the edge of total destruction. Wetlands in tropical regions are exposed to the negative impacts of population growth, climate change and upstream water uses. Wetlands along regulated rivers are threatened by desiccation caused by river bed incision and floodplain aggradation. The current management strategies are unable to cope with these threats. It has been concluded that local management interventions need to be coupled with basin-scale actions to turn the state of wetlands from vulnerable to resilient.

The WETwin approach for stopping and reversing the degradation of wetlands is based on four basic premises: wise use; adaptive management; integrated water resource management; and participation of local stakeholders. The project developed and tested a Decision Support Framework, which provides a structured approach to identifying and evaluating management solutions. Evaluations were carried out with the help of models and qualitative tools.

Involvement of stakeholders from the case study sites played a crucial role in the project. Trade-offs between different stakeholders were explicitly addressed. Stakeholders often side-stepped conflict and trade-offs by seeking compromise within the proposed management solutions: that is, by seeking solutions that packaged measures responding to the concerns of all groups (‘no-regret’ solutions). Managing for multiple ecosystem services inherently involved maintaining the health of the wetland, and vice versa.

The case studies also shed an interesting light on the realities of interactions between scales. Stakeholders were usually aware of the potential impacts of catchment development on their wetland, but saw these impacts as outside their sphere of influence and hence as inevitable. Whereas stakeholders were prone to propose no-regret solutions at the local scale, they accepted imposed trade-offs at the larger scale. This reflects the realities of the governance structures, where devolution of management responsibility to local agencies is relatively recent and not matched by changes in the real balance of power in decision making. Conversely, in most cases, management of the wetland was seen a primarily local concern with little relevance for those outside the area.

Project context and the main objectives

Despite their national / international protection status (e.g. under the Ramsar Convention), many wetlands lack proper planning and management. This often leads to the deterioration of their status. The reason behind this is not necessarily the lack of funding. In many cases the problems are rooted in the institutional environment: unclear or overlapping spheres of authority, lack of effective power to enforce laws and regulations, inadequate involvement of stakeholders - to mention a few. Furthermore, wetlands are often viewed as standalone systems rather than as elements of the river basin, and as a result are poorly integrated into river basin management.

Wetlands provide multiple ecosystem services on both local and basin scales (Finlayson et al. 2005). These services range from habitat, food and raw material provision, through flood and water quality regulation, to recreation and tourism. In some cases there are trade-offs among these services meaning that enhancing one service tends to cause deteriorations at the others. This may lead to conflicts among the stakeholders benefiting from the different services. Integrated wetland management is thus often framed as a decision problem with conflicting multiple objectives, where the challenge is to identify the best compromise management solution.

Wetlands are exposed to the impacts of perturbations, especially to that of demographic changes, socio-economic changes, climate change and morphological changes. Population growth in developing countries will likely increase the demand for provisioning and regulating services of wetlands, at the expense of habitat and cultural services. Wetlands are highly vulnerable to climate change (Ramsar, 2002). Decrease in precipitation and increase in temperature could seriously decrease the water resources of the wetland thus endangering all of its functions and services. Wetlands in regions like the Sahel are especially exposed to this threat (IPCC, 2007). Riverine wetlands are exposed to the negative impacts of morphological changes. Aggradation of the wetland surface, incision and lateral migration of the riverbed tend to lead to the desiccation or destruction of these wetlands. All these perturbations will likely cause the degradation of the wetlands in the future unless appropriate management measures are taken to counteract the negative effects. Adequate planning of management measures however requires accurate, quantitative assessments of vulnerabilities.

Planning and management of wetlands require information about the bio-physical status and processes. In many cases the availability of such information is rather constrained, and there is little chance to fill the gaps due to limited financial resources. Planning and management of wetlands in such data-poor environments require new approaches and methodologies.

Given all these problems and challenges, the following generic objectives were formulated for the WETwin project:

- Reveal environmental, institutional, social and management factors endangering wetlands at present and in the future
- Support the identification of community based technical and institutional solutions for the management of wetlands with the aim of utilizing their provisioning and regulating services

for the benefit of people, while preserving (and also improving as much as possible) their ecological and cultural values

- Support the integration of wetlands into river basin management and planning, by taking relevant national and international policies/guidelines into consideration, and also by accounting for the envisaged community service functions of wetlands
- Support the identification of strategies for adapting the management of wetlands to the changing environmental conditions

The focus of the WETwin project is on inland wetlands that are closely linked to the river basin.

The project studied 'twinned' case study wetlands from Africa, South America and Europe (Figure 1) to draw out common lessons and conclusions. These wetlands were investigated with the aim of supporting the achievement of project objectives on the case study level and evolving a more general comprehension of wetland management, with particular emphasis on data-poor circumstances.

Figure 1: Locations of the case study sites of WETwin

The sites were selected in order to address the challenges and objectives of WETwin.

A further consideration was to select different kind of wetlands in order to come up with a set that is representative of the diversity of inland wetlands.

The major attributes of the case studies are as follows:

- International protection status: Inner Niger Delta (IND), Abras de Mantequilla (AdM), Nabajjuzi, Lobau and Gemenc wetlands are all Ramsar sites
- Exposure to population growth and climate change: IND, Nabajjuzi, Namatala, AdM and GaMampa wetlands
- Exposure to morphological changes: Gemenc, Lobau, IND and GaMampa wetlands
- Provisioning and regulating services play a key role: IND, AdM, Nabajjuzi, Namatala, GaMampa and Gemenc wetlands
- Habitat and cultural services play a key role: IND, AdM, Nabajjuzi, Gemenc and Lobau wetlands
- Large wetland: IND (4,119,500 ha)
- Medium-size wetlands: Nabajjuzi (6,500 ha), Namatala (26,000 ha), AdM (29,053 ha) and Gemenc (18,000 ha) wetlands
- Small wetlands: GaMampa (100 ha) and Lobau (2,200 ha) wetlands
- Wetlands in the temperate zone: Gemenc, Lobau and GaMampa wetlands
- Wetlands in the wet tropical zone: AdM, Nabajjuzi and Namtala wetlands
- Wetland in the dry tropical zone: IND
- Strong hydrological link between the wetland and the river: all sites
- Conflicts over the use of ecosystem services: all sites

For the implementation of the WETwin project, an international consortium has been formed with the following research and educational institutions as partners:

1. VITUKI Environmental and Water Management Research Institute Non-profit Ltd., Hungary (Coordinator)
2. ANTEA Group, Belgium (Co-coordinator)
3. PIK Potsdam Institute for Climate Impact Research, Germany
4. WasserKluster Lunz, Austria
5. UNESCO-IHE Institute for Water Education, The Netherlands
6. NGO Wetlands International, Mali
7. National Water and Sewerage Corporation, Uganda
8. International Water Management Institute, South Africa
9. ESPOL Escuela Superior Politécnica del Litoral, Ecuador

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Main S & T results/foregrounds

1. Stakeholder analyses and engagement

Involvement of stakeholders from the case study sites played a crucial role in the WETwin project. Their knowledge, opinions and preferences were requested at several stages during the project. Stakeholder involvement was organized according to the strategies that were developed on the basis of detailed stakeholder analyses. In case of the African and South American case studies, stakeholder consultations took place in regular workshops organized within the frame of WETwin. At the European case studies, stakeholder involvement was realized through partner projects that were running parallel with WETwin.

2. Natural and socio-economic status

The WETwin project applied an *Ecosystem Services* approach for the characterisation of the natural and socio-economic status of wetlands. Identification of Ecosystem Services of the study sites has been carried out following the methodology given in the Millennium Ecosystem Assessment (Finlayson et al., 2005) and The Economics of Ecosystems & Biodiversity (TEEB, 2010) projects.

Characterisation was followed by the identification of major environmental and livelihood issues/problems at the wetlands. Cause-effect mechanisms behind the problems were explored with the help of the *Driving-forces, State, Impact and Responses* (*DSIR*) methodology, which is a simplified version of the DPSIR methodology that was introduced by OECD (1994), and developed further by UNCSD (1996) and Becker (2005). The DSIR methodology also helped in screening measures (responses) with which the problem can be solved. Information and data for characterisation and problem definition were collected from literature and also from the stakeholders directly.

The following major problems have been identified at the case study sites:

Desiccation and terrestrialization:
Due to water intakes from the River Niger upstream of the IND, the inflows to the wetland have been decreasing considerably especially during weak floods. This problem has further been enhanced by climate change, which decreased the precipitation on the upper catchment and increased the evaporation in the delta. As a result several wetland habitats have been destroyed or decreased in size causing the destruction of related ecosystems and ecosystem services. In addition, upstream water intakes and climate change are likely to intensify the process of desiccation of the IND in the future. Similar danger is threatening the AdM and Nabajjuzi wetlands due to the planned additional water intakes upstream. The riverine Gemenc and Lobau wetlands, as well as the GaMampa wetland have also been damaged by desiccation and terrestrialization, although the underlying causes are different: riverbed incision and floodplain aggradation at Gemenc and Lobau, agricultural drainage at GaMampa.

Encroachment and disturbance:
As a result of population growth, more and more wetland areas are being encroached by housing and agriculture, especially in developing countries. Regarding the WETwin case studies, the Namatala, Nabajjuzi, GaMampa and AdM wetlands are affected. The alluvial forests of the Gemenc wetland have been and are still being destroyed by recurrently planting and clear-cutting allochthonous tree species for timber production purposes. Ecosystems of all sites are exposed to the negative impacts of disturbances caused by agricultural, forestry, harvesting, fisheries and recreational activities.

Pollution:
Discharging untreated communal waste-waters into the Niger River frequently causes severe diarrhoea and cholera diseases in the population of the IND. Furthermore, the high nutrient content of these waste-waters, plus the nutrient rich runoff waters coming from the agricultural lands, result in eutrophication problems in this wetland. The proliferated invasive weeds (Water Hyacinth, Salvinia, Mimosa) obstruct navigation and fishing and results in habitat degradation in the IND. Similar benthonic eutrophication problems have been observed in the AdM wetland. In case of the Gemenc and Lobau wetlands, occasional planktonic eutrophication causes damages to the ecosystem.

Vector-borne diseases:
Malaria and schistosomiasis tend to occur in the neighbourhood of tropical wetlands because these wetlands provide habitats for the vectors (mosquitoes and snails) of these diseases. Among the WETwin sites, the population of the IND is threatened the most by these diseases, especially because the irrigated rice fields next to the IND provide even better habitats for these vectors than the wetland itself.

Since the case study sites of WETwin are considered as a representative set, the problems described here can be generalized for all inland wetlands of the World.

3. Vulnerability assessments

Vulnerability and resilience have become important elements in discussions of global change, but are conceptualised differently in different studies: see, for example, reviews by Gbetibouo and Ringler (2009), Fussel and Klein (2006) and Turner et al. (2003). Within WETwin, we were primarily concerned with the role of management in reducing vulnerability (or increasing resilience) of wetland systems to change; and with the degree to which strategies, envisaged by the current management, remain viable in the face of change. For this reason, a *framework for assessment of vulnerability* was adopted that focuses on adaptive capacity relative to impacts of external change.

Vulnerability Assessment (VA) is thus a useful tool to:

- identify existing and/or future general and specific problems in the area of investigation
- raise awareness of existing and/or future problems
- explore uncertainties related to possible future changes using scenario analysis
- find management solutions that are robust under changing conditions

Vulnerability is described in terms of two components: external impact (EI) and adaptive capacity (AC). External impact is a function of exposure to stressors and the sensitivity of the system to that stress. Adaptive capacity is the extent to which these impacts can be withstood or mitigated.

Scenarios are used to investigate future vulnerability. The difference between the current system state (baseline) and a business as usual (BAU) scenario system state is used to determine or quantify external impacts using quantifiable *indicators*:

EI = State(BAU) – State(current)

The BAU scenarios are scenarios where the system is exposed to perturbations (e.g., climate change, upstream or external land and water management etc.) assuming no change of management in the system under consideration. Such scenarios reveal the consequences for human-ecological systems if no changes in future (re)action or no adaptation to changing boundary conditions take place.

Adaptive capacity is quantified by comparing the system states of the scenarios including management State(mgt) and not including management State(BAU):

AC = State(mgt) – State(BAU)

The change in vulnerability (residual vulnerability or ΔV) of the system as it moves from its initial state to a new state can be described by the sum of (usually negative) external impacts and (usually positive) adaptive capacity, that is:

$\Delta V = EI + AC$

$\Delta V = State(mgt) - State(current)$

Where the adaptive capacity of the system exceeds the external impacts ($AC>EI$, $\Delta V>0$), the system is resilient; where external impacts exceed adaptive capacity ($EI>AC$, $\Delta V<0$), the system is vulnerable.

3.1 Application of the vulnerability framework on the case studies

The vulnerability framework was applied specifically to quantify the vulnerability of food production (floating rice) in the Inner Niger Delta to upstream reservoir management, population growth and climate change, including its variability, during the time period 2011-2050. The impacts on the water balance and inundation patterns in the Delta were simulated using a process-based eco-hydrological modelling system equipped with an inundation module and a reservoir module (the SWIM model). The simulated usable inundated area was used as a proxy for the area for floating rice production in the Delta. Both projected climate change and upstream reservoir management lead to a significant reduction of peak discharges during the rainy season and hence to serious losses of potential agricultural areas within the Inner Niger Delta. The effectiveness of the planned extension of irrigated rice areas within the Delta, in order to mitigate the losses of areas suitable for floating rice, was investigated as an adaptive measure. This land use change fulfils increasing food

demands under some scenarios, but at the expense of other ecosystem services, especially habitat services.

Besides the Inner Niger Delta, the Abras de Mantequilla, Nabajjuzi, Namatala and GaMampa wetlands have also proven to be vulnerable to increasing upstream water use, population growth and climate change. Actually these stresses are common threats to many wetlands in the tropical regions of the world. Unfortunately the current management agencies of these wetlands are either not prepared for coping with these threats, or do not have sufficient resources to do so.

Quantitative vulnerability assessment was carried out also with regard to the Danube riparian Gemenc wetland. This wetland is exposed to the impacts of river bed incision, floodplain aggradation and climate change. Climatic, hydrological and morphological models were used to quantify these stressors as synthetic precipitation surpluses, river water levels and wetland topographies over the time period 1990-2050. These scenarios were then used as boundary conditions for model-based simulations of the wetland's water regime at present and in the future. The effectiveness of the planned retention sluices, by which waters are aimed to be withhold on the floodplain after floods for the benefit of alluvial ecosystems, was investigated as adaptive measures. The results of these investigations demonstrated that the Gemenc wetland is highly vulnerable to the combined impacts of floodplain aggradation, river bed incision and climate change. The area is subject to an intensive terrestrialization process, which the proposed adaptive measures are able to counteract only in the short term. It can be stated with reasonable confidence that this wetland will dry up completely within a century from now, resulting in the total annihilation of its characteristic ecosystems and ecosystem services.

Because riverbed incision, floodplain aggradation and climate change are generic phenomena along regulated rivers, most wetlands along these rivers are exposed to similar degradation. The Danube riparian Lobau wetland for example is undergoing progressive terrestrialization and is being threatened by total desiccation, like the Gemenc. Since floodplains play a key role in the maintenance and functioning of ecosystems and ecosystem services at basin scale, restoration and sustainable management of these sites should be a high priority in river basin management.

Thus, wetlands worldwide tend to be in vulnerable state, due to various external stresses. In addition, the current management strategies are usually not able to cope with these threats. One of the main reasons is that decision makers tend to view the impacts coming from the river basin as unchangeable boundary conditions, which are out of the scope of wetland management. This suggests that as well as appropriate management interventions on local scale, large-, basin-scale actions are also needed to turn the state of the wetlands, and also that of the basin, from vulnerable to resilient.

4. Institutional analyses

Analysis of *institutional capacity* was implemented to reveal the obstacles that hamper the wise use of wetlands. A new *framework* was developed for the analysis that comprised a set of indicators to analyze the presence and effectiveness of formal regulations and procedures, and relevant informal

mechanisms for wetland management. The set of indicators is designed based on internationally recognized objectives and standards for wetland management given in the Ramsar guidelines. Application of the framework on the case studies showed that institutional capacity for wetland management is often insufficient, especially in the developing countries. Capacities are usually strongest at the policy level and weakest at local level, where policies are to be implemented. In most cases the institutional and legal framework for water and wetland policies is in place. Some case studies such as the Inner Niger Delta, Nabajjuzi, Lobau and Gemenc wetlands even have specific wetland management plans. The biggest bottleneck observed in all case studies is the lack of implementation of the existing policies and plans. Reasons include the lack of human, financial and organizational capacities to actually implement and enforce these policies. In addition, there is a mix of new formal legislation and procedures, having been put in place recently, and informal instruments and planning/management practices from the past, which are still used by wetland managers and stakeholders. Capacity of the wetland management institutions to deal with external stresses (e.g. climate change) seems limited. Thus, wetlands require improved institutional capacity, as an integral part of wetland management with the overall objective to bring the human-induced and climate-increased degradation to a halt. Wetland managers should select future actions that consider a tiered or time-lined approach that accounts for their capabilities and institutions. Strengthening capacity will allow for a progressive strengthening of actions over time.

Wetlands are often viewed as standalone systems rather than as elements of the river basin. As a result wetlands are poorly *integrated* into river basin management, both in the case studies from Europe and from the developing countries. Although the physical size, type of use and governance context of the European, African and South American wetlands are vastly different, the underlying management question is the same: how to synchronize the requirements of the wetland with management imperatives from the broader river basin. The project identified two common barriers: mismatch between local and national or catchment level priorities; and lack of recognition of the ecosystem services provided by wetlands to the broader catchment. These failures in mutual understanding across scales are attributed to a lack of accessible information on status, trends, important values and targets for wetland management. It has been concluded that cooperation and exchange of information across levels of government may be more important than full integration of planning processes. This can be addressed through the involvement of stakeholders at all levels, and through structured, transparent methods for assessing ecosystem services, setting priorities for ecosystems and livelihoods, and evaluating management options. In contexts such as the IND (and many other developing regions) where data are sparse, structured assessments based on best available information and local knowledge can provide valuable negotiation-support tools, even if the quality of the data does not warrant the use of true decision-support tools.

5. Towards integrated, adaptive and participatory management of wetlands

The WETwin approach for stopping and reversing the ongoing degradation of wetlands is based on the four basic premises of wetland management: wise use; adaptive management; integrated water resource management; and participation of local communities and stakeholders. “Wise use” (Ramsar Convention Secretariat, 2007) encapsulates the understanding that wetlands provide a wide

range of ecosystem services and are important components of livelihood systems. As such, the aim is to manage for a range of functions, not only for conservation values, but to do this in ways that protect and enhance ecological status. Adaptive management recognises management as an on-going cyclical process; the critical components of such an approach for wetland have been described by Dickens et al. (2004) in the "Critical Path" approach, adopted by Ramsar as a standard for wetland management (Ramsar Convention Secretariat, 2007). Integrated water resource management acknowledges that wetlands function within a hydrological context, where the management of the catchment impacts on the health of the wetland; and the wetland contributes to the overall functioning of the catchment (CIS, 2003; UNESCO, 2009).

The *Conceptual Framework* for wetland management developed in the WETwin project nests adaptive management of the wetland within the adaptive management cycle of the river basin, with on-going feedback between the two (Figure 2). An actual merge or transfer of responsibilities is not envisaged, since wetlands have their own dynamics, need to be managed at a different scale and have different challenges than river basins. Participatory planning and management recognises that local communities and stakeholders are ultimately both the actors and the beneficiaries of management, and must be involved at all stages (UN, 1994).

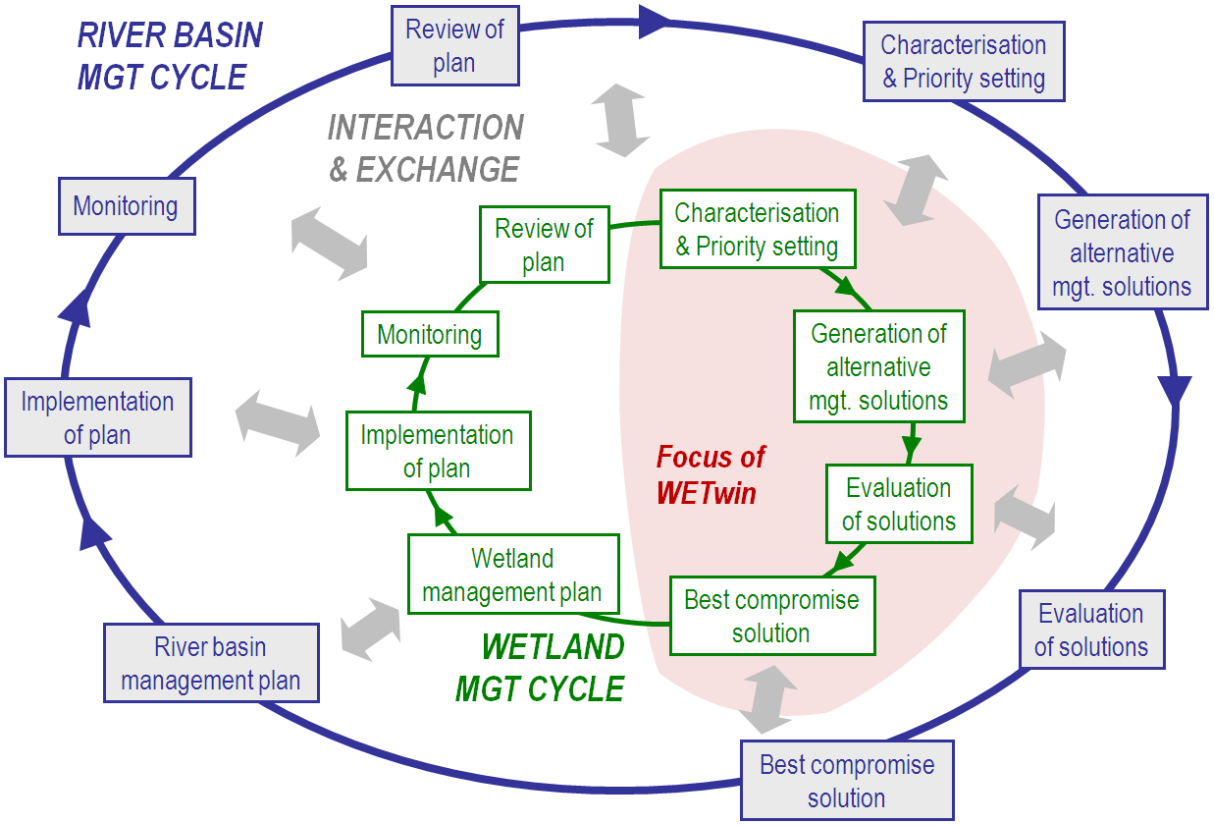

Figure 2: The concept developed by the WETwin project for the adaptive and integrated wetland and river basin management

Both planning cycles, at wetland and river basin scale, consist of classical elements of a regular project management cycle (see also Figure 2):

- Initial multi-disciplinary characterization incl. biophysical, socio-economic, and institutional status/capacities; identification of problems and priorities: based on the ecosystem services and DSIR approaches

- Generation and evaluation of alternative management solutions. This ideally results in a 'best compromise solution' identified together with decision-makers and stakeholders.

- At both catchment and wetland scales, management plans are built upon the basis of the best compromise solution (or solutions). This management plan should also take key aspects of the other plan (either wetland or river basin) into account.

- A final step of the planning cycle is monitoring and evaluation of the process of implementation, with review of the existing plans consistent with adaptive management principles. Monitoring and process evaluation must be planned well in advance at the start of the next management cycle.

The focus of the WETwin project was to contribute to management plans for each case study wetland, by working with stakeholders to identify and evaluate potential management solutions (see Figure 2). Implementation and monitoring of plans is the responsibility of local authorities and stakeholders, and was not part of this project. The scope of the project was thus restricted to the preparatory and planning stages of the Critical Path adaptive management cycle. This sub-system has been developed into a *Decision Support Framework* (DSF), drawing on concepts from Gamboa (2006) and Paneque Salgado et al. (2009).

The first step of the DSF procedure is thus characterisation, and identification of problems and priorities. This is followed by the identification of management solutions, which starts with the survey of potential management options. Options (or 'responses' according to the DSIR terminology) are different sector-specific measures for improving the health and ecosystem services of wetlands. In each case study, management options to address specific wetland issues were identified in consultation with stakeholders, drawing on international experience. The DSIR methodology has proven to be a useful tool for supporting this process. In most cases, a mix of technological and local regulatory options (mainly land use zoning and restriction of agrochemicals) was proposed. Working at the community level, economic and legal mechanisms were not favoured, or were perceived as beyond the capacity or responsibility of local groups.

Because of the multiple values of wetlands, management usually addresses more than one component or ecosystem value. Options addressing specific components or issues are combined in packages of complementary or compatible interventions. These packages are the management solutions, which will provide desired outcomes for the wetland system as a whole. Options can be combined as complementary (addressing different elements of system); enabling (interventions designed to support or enhance another intervention – for example, land tenure changes to support land use change); or mitigating (interventions designed to offset or compensate for adverse impacts of another intervention). Formulation of management solutions from a long list of potential options requires a pragmatic approach to selecting feasible combinations and narrowing down to a practical

number for evaluation, based on stakeholder preferences and practical considerations for implementation.

Evaluation of different potential management solutions for the case study wetlands was a complex, inherently multi-dimensional problem, needing to take account of multiple functions, services and values of the wetland, multiple stakeholders with varying perspectives, and feedback between the wetland and the catchment. Choice of a management regime is essentially a multi-criteria decision problem, and the DSF is structured around using *multi-criteria analysis* (MCA) as a primary evaluation tool that supports assessment of impact, feasibility and trade-offs, and provides rankings of alternative management solutions on the basis of their assessed impacts and also on that of the preferences of stakeholders. The approach is based on a combination of participatory methods, observations and modelling tools. A requirement of the project was to provide methods to combine data from different sources and of different degrees of accuracy, suitable for use in contexts where hard data are often not available. Methods were developed using comparative scoring, based on both quantitative and qualitative information. Stakeholder acceptance was assessed directly through consultation and participatory approaches to planning.

In the WETwin project, the MULINO Decision Support System (*mDSS*) was used to facilitate the MCA approach. mDSS was developed under the EU Framework Programme, to assist decision makers in managing environmental issues in catchment scale water resource management (Giupponi, 2007). The input for mDSS consists of three main components:

- *indicator values* of the alternative management solutions derived by models or by qualitative assessment tools;
- *value functions* that normalize the raw indicator value into comparable *criteria scores* between 0 and 1;
- *weights* assigned by the different stakeholders to the different criteria, according to their preferences.

For ranking the alternative solutions, mDSS offers well-known decision support techniques such as Simple Additive Weighting (SAW), Ordered Weighted Averaging (OWA), Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) and ELECTRE. Within WETwin, only the SAW and TOPSIS approaches were used.

5.1 Application of the Decision Support Framework on the case studies

For the *GaMampa* wetland, different management solutions were formulated, with input from the stakeholders, to emphasise specific outcomes (economic, social, environmental) and to explore integrated solutions where potential trade-offs were explicitly addressed and incorporated into the planning. Potential trade-offs identified for the wetland are primarily between food production and other uses, dominantly traditional collection and hydrological regulation. There is also potential conflict between cultivation and livestock grazing. The solutions were scored by the research team on the basis of information collected through hydrological monitoring, field observation, household surveys, expert interviews and stakeholders' input, and correspond to a qualitative expert judgment; it is meant to be updated with results from ongoing modelling efforts (WETSYS). This process necessarily results in some uncertainties on criteria scores and therefore the results of assessment should be considered with caution. An integrated solution (incorporating drip and gravity irrigation

schemes, grazing control, retention of 50% of the wetland under natural conditions and a locally administered wetland management plan) consistently scored highest in the MCA. Results were not sensitive to the set of weights or decision rule. Individual stakeholder ranking based on weights confirmed this result: the integrated solution is preferred by all stakeholders but one. The analysis indicated that the best performing solutions in terms of impacts are also the most difficult to implement due to high costs and institutional complexity, emphasizing the importance of supporting programs to improve local and institutional capacity when implementing natural resource management programs. In comparing expert scoring with direct ranking by stakeholders, the most striking difference is that although the integrated solution is always the preferred one when ranking is based on criteria scores, it is almost never chosen among the best solutions when performing direct ranking. Individual choices among the GaMampa community members of this group were very homogeneous and targeted towards economic development. This may be attributable, at least in part, to the fact that when making their choice stakeholders only focus on a limited number of criteria, due to cognitive complexity, although when asked to assign weights to criteria they very rarely consider giving zero weights to any criteria. Further work with stakeholders is needed to identify a unique compromise solution; and to explore the vulnerability of the system to external change.

In *Abras de Mantequilla* (AdM), proposed management solutions were formulated as progressively more comprehensive packages of options relating to sustainable land management, in combination with improved agricultural practices. Increased water retention through operation of hydraulic gates was included as a component of all management solutions, as a response to upstream development. Nineteen indicators in seven criteria categories were used to evaluate the solutions. Two quantitative indicators were assessed using a complex hydrological model system. All other indicators were scored qualitatively using expert judgment by a panel of local experts. In the way the AdM case study has been conceptualized, the scenarios and management solutions are wrapped together. Solution 0 is BAU under an assumed set of climate, population and infrastructure conditions. The proposed management solutions were ranked in MCA by combining scores for all criteria, weighted according to preferences of three different stakeholder groups. The more comprehensive solutions (which combine improved agricultural practices with conversion of crops to agroforestry) were preferred in all cases.

At *Nabajjuzi*, alternative management solutions were identified to address changes in water supply, improvements in water quality (through waste water treatment and collection) and protection of the watershed. Main potential trade-offs identified are between resource harvesting (water, papyrus) and ecological function; and between agriculture and water quality. Management options were evaluated using expert judgement, by scoring criteria relating to impacts on the system (ecosystem health and ecosystem services); and to feasibility / ease of implementation (direct costs, context dependence, technical considerations). Ranking using MCA was very dependent on the weighting of criteria. Four different weights sets were explored, expressing different stakeholder priorities. The solutions which consistently score highest using the “expert” weightings are those combining rehabilitation of the current wastewater treatment and natural wetland with improved sanitation at household level and measures to protect ecological status of the site. In terms of water supply, both increasing abstraction from the current intake and extension of the water network provide

satisfactory results. The analysis used for Nabajjuzi provided an effective way to structure and analyse complex information relating to multiple options, but did not provide a single answer as to the "best" solution. Further work is needed with stakeholder communities to ascertain priorities and preferences.

Five management solutions are proposed for *Namatala* with different foci: water quality; land management and conservation; and an integrated solution drawing together aspects of both. Within these solutions, alternatives are considered with different degrees of financial effort. Management solutions were scored using expert judgement on the basis of three impact criteria (livelihood, human health and ecology) and two feasibility criteria (costs and risk of failure). While the proposed solution integrating land use change in the upper and lower wetland with improved waste water treatment has the most suitable outcomes in terms of impacts on human health, livelihoods and ecology, it is judged to be costly and with high risk of failure. The simpler solution focusing on management of papyrus harvesting and buffer strips provides similar outcomes with lower cost and risk. The favoured management solution optimises both livelihood and ecosystem impacts, although there are trade-offs with the human health criterion. Within the livelihood criteria, there is a conflict between rice cultivation and both fish and papyrus production. Inclusion of criteria weighting to express stakeholder preferences for specific outcomes did not alter the ranking of solutions, which were the same for all stakeholder groups.

In case of the *Lobau* wetland, WETwin capitalized on the outcomes of the Optima Lobau project (Hein et al, 2006). The 6 hydraulic- and 5 land use options identified by Optima Lobau were combined into 30 management solutions, which were evaluated against 8 criteria. The purpose of the hydraulic options was to develop a hydraulic gradient ranging from complete isolation to full re-connection of the Lobau floodplain with the Danube River channel. The five use-options included dominant ecological development, dominant drinking water production, dominant recreation, dominant agriculture, and dominant fishery. Nine decision maker types were identified based on their preferences on the management criteria. Trade-off analysis revealed that trade-off exists between the criteria that scored higher for the increased hydraulic connectivity solutions and the criteria that scored higher for the lower hydraulic connectivity solutions. The criteria that scored high for the increased hydraulic connectivity solutions include development of aquatic habitats, potential flood reduction and potential fishery. The criteria that scored low under increased hydraulic connectivity solutions include the ecological conditions of the terrestrial habitats, potential drinking water and the potential cost reduction. No management solutions dominated according to all criteria. According to the MCA, the hydraulic option that increases the water input from the upper part of the Lobau floodplain with restriction of socio-economic utilization to sustainable fishery seems to be the most acceptable solution to most decision maker types. The research also added new insight to the Optima Lobau project.

Application of the DSF methodology on the WETwin case studies has resulted in important generic conclusions:

- In most cases, results of MCA were not highly sensitive to ranking method, but were much more strongly affected by changes in weightings. Ranking became more an exploration of the preferences of different stakeholders than a definitive way to "choose" solutions,

concurring with the findings of Hajkowicz and Collins (2006) that the strength of MCA is as tool to support discussion, rather than a primary decision making tool.

- The MCA was conceptually structured to allow analysis of trade-offs between different criteria. However, major trade-offs identified in the initial DSIR assessments often either were, or were perceived to be, outside the management domain of the wetland managers. Trade-offs between different stakeholders within the wetlands were explicitly addressed as part of the management solutions. Stakeholders side-stepped conflict and trade-offs by seeking compromise within the proposed management solutions: that is, by seeking solutions that packaged measures responding to the concerns of all groups. For example, in the GaMampa, Abras de Mantequilla and Inner Niger Delta, where there are potential conflicts between agriculture and wetland conservation, integrated solutions balancing the two emerged as the preferred option in community consultations. The strong preference for "no regrets" measures reflects the fact that for all stakeholders, a healthy wetland delivers more benefits.

- Although stakeholders acknowledged that trade-offs and conflicts exist, framing debate on ecosystem management in terms of trade-offs has its shortcomings, as it may "close the space for alternative development pathways" as Friend et al (2009) pointed out. In many cases, it was found that trade-offs are caused because of an insufficient insight into the collateral damage of a measure someone is taking for their own benefit; in others, trade-offs are driven by perceived or actual lack of alternatives. The role of the feed-back mechanism built into the WETwin DSF is exactly to help escaping from this trap, as it enables to identify new (better) alternatives on the basis of evaluation results and stakeholder opinions.

- The case studies also shed an interesting light on the realities of interactions between scales. Wetland stakeholders were usually very aware of the potential impacts of catchment development on the wetland, but saw these impacts as outside their sphere of influence and hence as inevitable (see also section 3. 'Vulnerability assessments'). Whereas stakeholders were prone to propose no-regret solutions at the local scale, they accepted trade-offs at the larger scale. This reflects the realities of the governance structures, where devolution of management responsibility to local agencies is relatively recent and not matched by changes in the real balance of power in decision making, especially for the African case studies. Conversely, in most cases, management of the wetland was seen a primarily local concern with little relevance for those outside the area. In this context, ecosystem service assessments - and their translation to local context - provided a useful starting point for understanding the wider values of wetlands and their importance for the river basin.

6. Data and tools

For facilitating the widespread analysis and modelling activities carried out at the case studies, several datasets of different kind and scale had to be assembled. These datasets range from hydro-meteorological and water quality time series, through GIS layers, to socio-economic information.

To store these data in a structured and transparent way, a database tool called Spatial Data Infrastructure (SDI) has been set up. One of the primary roles of the SDI system is to ensure a sustainable data transfer. It makes the meta-data (i.e. descriptions of data) available in a structured and geo-referenced way so that these data can be browsed and searched through the internet. The SDI-server has been set up at UNESCO-IHE with the aim that these services will remain available through the internet even after the end of the WETwin project. The SDI also links to other SDI initiatives in the institute and in other projects. For example: we were successful in transferring the meta-data from the AFROMAISON 7FP project towards the WETwin project and vice versa.

Gaps in datasets and lack of data proved to be acute problems hampering the work at most of the WETwin case studies. These problems were partly resolved by developing and applying different data interpolation and generation methods. The research team of the Abras de Mantequilla case for example adapted the Hodric-Prescott filter ((Hodrick and Prescott, 1997) for filling the gaps in the discharge time series of the Guayas River in Ecuador. The filled data set was then used as input for the different modelling studies carried out on the Guayas – Abras de Mantequilla river-wetland system. With regard to spatial data, a GIS methodology has been developed for building up high-resolution Digital Terrain Models (DTM) for open wetlands, from satellite images and recorded water levels. This methodology was successfully applied at the Inner Niger Delta (IND) wetland.

Qualitative vulnerability assessment at the IND was implemented with the help of the *SWIM* model. SWIM (Soil and Water Integrated Model) is a continuous-time spatially semi-distributed eco-hydrological model developed at the PIK for climate and land use change impact assessment (Krysanova et al., 2005). It simulates hydrological processes, vegetation growth, erosion, and nutrient dynamics at the river-basin scale. Within the frame of WETwin two new modules have been integrated into SWIM in order to facilitate the special simulation needs of the project. These are the inundation and the reservoir modules. The inundation module is required to adequately simulate the impacts of floods in the IND. It simulates the flooded surface area, inundation depths, and duration, as well as losses due to evapotranspiration and percolation. The reservoir module was developed in order to account for impacts of existing/planned dams on the discharges of the Niger River.

Besides the SWIM model, a *sophisticated model-system* has been initiated for the IND, on the basis of the high resolution DTM generated for this wetland. The hydrodynamic module of the system is a 2-dimensional finite-element surface flow model built up in the River2D (Steffler and Blackburn, 2002) modelling tool. This River2D module provides hydraulic boundary conditions for the habitat and water quality modules. The habitat module simulates the spatial distribution of habitat suitabilities of key species such as bourgoutiere, floating rice, wading birds and fish. The WQ module is applied for simulating the propagation of E. coli bacteria from the pollution sources (the settlements) throughout the channel system of the IND. These simulations would help managers and local leaders to understand the relationship between water-borne diseases and water regime, and to elaborate policies and emergency measures for preventing the breakouts of such diseases. Nevertheless, this model system requires further development before using it for supporting management decisions. This should be done during follow-up projects.

In case of the Guayas - Abras de Mantequila system, a *complex rainfall-runoff, channel runoff and water allocation model system* has been set up with the aim of simulating hydrological processes. Two rainfall-runoff models, using HEC-HMS (Sharffenberg and Fleming, 2010), computed river discharges from meteorological data, in the upper catchment. With this output, a river hydraulic simulation (employing HEC-RAS, (USACE, 2010)) was conducted in the river system, where the wetland formed a lumped module. Both simulations fed a water allocation model (WEAP, (Stockholm Environment Institute, 2009)), and this model assisted in the evaluation of the influence of climate change and major hydraulic projects in the basin as well as the proposed management solutions in the area.

A dynamic system simulation model, called *WETSYS*, was developed within the WETwin project using the STELLA® platform to simulate the impacts of alternative wetland management strategies and external pressures on wetland ecosystem functioning, ecosystem services and ultimately on community well-being in the GaMampa system. The model is divided into seven interactive sectors namely: hydrology (itself sub-divided into three sub-sectors: natural wetland, cultivated wetland and irrigation scheme), crop production, crop economics, irrigation management, natural resources use, land use change decision, and community well-being. The WETSYS model is being used to simulate different management interventions under various global change scenarios at GaMampa. Localized global change scenarios will include changes in climate, population dynamics and economic policies. Wetland management options to be simulated were discussed with stakeholders at local and provincial levels. They include (1) rehabilitation of the irrigation scheme, (2) introduction of crops more adapted to wetland environment and reduction of artificial drainage; (3) development of ecotourism with the launch of a recently built tourism facility; and (4) imposing controls on resource use in the wetland.

Due to data scarcity in the case studies, model-based evaluations had to be complemented with, or even replaced by, qualitative, expert judgement-based evaluations. Two rapid assessment tools developed in South Africa have been adapted and applied in WETwin for this purpose: *WET-Health* (Macfarlane et al., 2008) for assessing wetland health, and *WET-EcoServices* for evaluating ecosystem services provision (Kotze et al., 2008). These tools allow different levels of assessment, based on the degree of available information, from simple desktop analysis to rigorous field-based assessments. They are structured using checklists with detailed descriptions of the features to be scored and the rationale for assigning scores.

A wetland management role playing game, called *Wet-WAG*, has also been developed within the frame of WETwin. The primary purpose of the game is to raise awareness among stakeholders and decision makers dealing with wetlands. Wet-WAG has been tested on the GaMampa case study during one of the stakeholder workshops.

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Potential impact, main dissemination activities and exploitation of results

1. Dissemination at global scale

The results, conclusions and messages of the WETwin project are disseminated in the forms of project reports, factsheets, newsletters and journal articles. The targeted audience are researchers and wetland managers on global scale. WETwin has been presented by the consortium members on a large number of events and several exchanges have taken place between the project staff and other experts and stakeholders. The main dissemination events have been conference presentations, networking events and twinning workshops.

Several platforms are being used to continue disseminating information and the results even after the official end of the project; the website (www.wetwin.net) will remain active and content will be integrated in other sites and initiatives by the Commission, WETwin partners and related projects. Throughout the duration of the project relations have been maintained with a number of international groups. Especially the contacts made with the RAMSAR SRTP are important. WETwin outcomes – particularly guidelines on vulnerability assessment – are planned to be taken up by RAMSAR. At this stage a box on the vulnerability assessment method by WETwin has been included in the RAMSAR technical Report N°.5 / CBD Technical Series N°57 – A Framework for assessing the vulnerability of wetlands to climate change.

Publishing *papers in peer-reviewed scientific journals* is another important way of disseminating project results. A series of papers covering the full spectrum of project outcomes has been submitted to be published in a special issue of the journal Environmental Science and Policy, which will be entirely dedicated to WETwin (Table 1). Papers have been and will be published in other recognized journals as well, such as the Environmental Management, Hydrological Sciences Journal, Water Science and Technology (Table 2) and the Journal of Geomorphology.

Table 1: Overview of papers submitted to the special issue of the journal Environmental Science and Policy

- Zsuffa, I., Johnston, R.M., Cools, J., D'Haeyer T. WETwin: an introduction
- R.M. Johnston, J. Cools, S. Liersch, S. Morardet, C. Murgue, M. Mahieu, I. Zsuffa, G.P. Uyttendaele. WETwin: a structured approach to evaluating wetland management options in data-poor contexts.
- Liersch, S., Cools, J., Kone, B., Koch, H., Diallo, M., Aich, V., Fournet, S., Hattermann, F.F. Vulnerability of food production in the Inner Niger Delta to water resources management under climate variability and change.
- L-M. Rebelo, RM Johnston, T. Hein, G. Weigelhofer, T. D'Haeyer, J. Cools. Integrating wetlands into IWRM: the case study of the Inner Niger Delta (Mali) and the Lobau Floodplain (Austria).

- Pataki B., Zsuffa I.. Hunyady A. Vulnerability assessment for supporting the revitalisation of river floodplains.
- Cools, J., Diallo, M., Liersch, S., D. Coertjens, Vandenberghe V., Kone, B. Integrating human health into wetland management for the Inner Niger Delta, Mali.
- Arias-Hidalgo, M., Villa-Cox, G., Van Griensven, A., Solórzano, G., Villa-Cox, R., Mynett, A.E., Debels, P. A multi-criteria analysis for wetland management in a river basin context: the "Abras de Mantequilla" case study in the Guayas River Basin, Ecuador.
- E. Ostrovskaya, W. Douven, K. Schwartz, B. Pataki, P. Mukuyu, R. Kaggwa. Capacity for sustainable management of wetlands: Lessons from the WETwin project.
- Namaalwa, S., van Dam, A.A., Funk, A., Ajie, G.S., Kaggwa, R.C. A characterization of the drivers, pressures, ecosystem functions and services of Namatala wetland, Uganda.
- Funk, A., Reckendorfer, W., Gschöpf, C., Blaschke, A.P. Ecological niche models for the evaluation of management options in an urban floodplain ─ conservation vs. restoration purposes.
- Alvarez-Mieles, G., van Griensven, A., Torres, A., Arias-Hidalgo, M., Mynett, A.E. Relationship between aquatic biotic communities and water quality conditions in a tropical river wetland system.
- Baart, I., Hohensinner, S., Zsuffa, I., Hein, T. Historic development as a precursor for future floodplain management
- Cools, J., Johnston R.M., Hattermann, F.F., Douven, W., Zsuffa, I., D'Haeyer, T. Tools for wetland management: lessons learnt from a comparative assessment

Table 2: Overview of papers submitted to other peer-reviewed scientific journals/books

- Koch, H., Liersch, S., Hattermann, F. F.: Integrating water resources management in eco-hydrological modelling. Submitted to: Water Science & Technology.
- Clouting-Helbron H., Douven W., Ostrovskaya E., Schwartz K. and B. Pataki. Framework for Analysing Institutional Capacity for Wetland Management - Case Gemenc Wetland. In print: Albrecht, E., et al. (eds.). Implementing adaptation strategies by legal, economic and planning instruments on climate change, Springer, Heidelberg.

At the time of submitting this Final Report (August 2012), about 80% of the above-listed papers have already been accepted for publication. Papers of WETwin that have already been published in scientific journals are listed under section 4.2 'Use and dissemination of foreground' of the Project Final Report.

WETwin has been presented on the kick-off meeting of the FP7 AfriCAN Climate project on Uptake of Climate related Research Results through Knowledge Platforms with African Collaboration Partners. The main aim of the AfriCAN Climate project is the development,

operation and promotion of a web-based Knowledge Platform for efficient dissemination of climate change research results and good practices, to encourage users for uptake of success stories and research knowledge in new projects. Results from WETwin, including main reports, factsheets and guidelines will be shared with the AfriCAN Climate project, and possibilities for a wetlands management practitioners group on the web-based Knowledge Platform are being considered. Several WETwin partners are also involved in other projects awarded under the FP7. Some of these projects are working in the same case study sites, which ensure the uptake and utilization of WETwin results. These projects are AFROMAISON, DEFORWA, IMPACT2C, Aquastress and EAU4FOOD. AFROMAISON is especially important, since this project is applying and refining the methods and tools developed by WETwin in a broader land management context.

The Wet-WAG role-playing game can be adapted to other case studies in Africa. There is interest from several groups (e.g. South African National Biodiversity Institute; University of Limpopo) to use the game both as an environmental educational tool, and with farmers to support discussion on wetland management options.

Finally a series of non-technical *factsheets* is being prepared to provide a quick overview of various concepts developed and applied in the project, and examples from the case studies. These factsheets will be available on the website in screen and print-ready formats.

2. Potential impacts at global scale

The outcomes of WETwin are expected to enhance the recognition of the functions and services wetland ecosystems provide on local and on river basin scales. The alarming messages of the project about the degradation and vulnerability of wetlands will help to raise awareness in politicians, managers and stakeholders, and will bring conservation, restoration and sustainable management of wetlands more into the limelight. Decision makers worldwide are encouraged to introduce adaptive wetland management plans, which are in harmony with the river basin management plans, and which have been developed in a participatory way, by taking into account objectives and interests of different groups, as well as constraints and threats. Efficient implementation of such plans requires an improved institutional environment, as it has been demonstrated by WETwin.

To support this planning process, WETwin offers the frameworks (vulnerability, institutional analysis and decision support), methods, models, datasets and databases that have been developed/adapted within the project, and applied for the case study wetlands. These tools are available for follow-up projects, to be developed further for more accurate vulnerability assessments, institutional analyses and multi-criteria decision analyses. Improving the models will require new field data that should either be acquired from existing data sources or generated by means of monitoring. The need for improved data acquisition and monitoring is repeatedly emphasized in the WETwin documents. It is envisioned that WETwin will motivate decision makers in charge to improve the monitoring programmes on their wetlands. Acquisition and processing of remote sensed data is recommended as an economic way for complementing, or even replacing, expensive monitoring programmes. For example, WETwin recommends the use of

satellite images with synchronic water level readings for building up the high-resolution DTMs of open wetlands like the Inner Niger Delta. WETwin also recommends acquiring water level data monitored in a remote sensed way. This kind of data will be generated by projects like the SWOT (Surface Water Ocean Topography) satellite mission, which will be launched in the near future.

While working for WETwin, several junior researchers, mainly from developing countries, have qualified for MSc and PhD degrees. The workshops and trainings organized within the frame of the project were attended by many students and professionals. By all these, WETwin contributed to capacity building on the field of integrated water resources management, especially in the developing countries.

Stakeholder platforms and twining cooperations established within WETwin are expected to support integrated and participatory wetland management both on local and global scales. Professional links with wetland research communities, established during workshops and conferences attended by WETwin staff members, will support wetland related research activities in the future.

3. Dissemination and potential impacts at the case studies

The WETwin project established participatory approaches to wetland management and planning for the *GaMampa* community. The priorities identified under WETwin have been communicated to the organizations in charge of local planning (IDP process) at community (ward councillor) and municipal (department of economic development). Municipal and provincial planning agencies were involved in stakeholder meetings, and introduced to the concepts and procedures involved, which may then be taken up by other groups. Exchange visits with other community wetland groups in nearby areas provided further exposure of the WETwin approaches, as well as allowing GaMampa people to inspect a rehabilitated wetland and understand the potential in GaMampa. A Mohlapitsi wetland project, partly funded by UNDP is on-going on the site, negotiated among stakeholders who participated in the WETwin workshops. It will use information on management options generated by WETwin as a basis of an action plan for the site. The Centre for Rural Community Empowerment (CRCE), an outreach organization within the University of Limpopo, which was a major stakeholder for the GaMampa site, has been appointed by UNDP as the implementing agent of this project.

Management objectives which have been identified at sub-basin scale of the *Niger – Inner Niger Delta system* using the methodology and tools developed in WETwin, are highly ranked in the agenda of many programs in Mali. These objectives are coherent with the Sustainable Development Program of the IND and also with the Action Plan for the Sustainable Development Program of the Niger Basin. As a result, there are opportunities for implementation of some of the solutions at Niger Basin and/or the Inner Niger Delta level. The solutions which have been analysed at wetland scale are integral parts of the priority action of the Sustainable Development Program of the IND (2011-2013). Under the WASH project funded by the Dutch Cooperation some of these management solutions will be implemented at local scale by Wetlands International and members of the WASH Alliance. Also, there will be an advocacy component in the same project for insertion

of these solutions in the Socio-Economic and Cultural Development Program of the partner rural districts through the members of the WASH Alliance. Members of the WASH Alliance in Mali will be trained to apply the approaches: participatory methods for defining management options, defining indicators linked to the latter, evaluating management options in terms of affordability/costs and institutional capacity/planning. It is expected that in the future planning procedures several partners will make use of the lessons learnt in WETwin. In the near future WETwin approaches may be applied in the Sikasso and Koulikoro regions in the frame of the WASH project.

Wetlands International is furthermore exploring possibilities to organise a number of additional dissemination activities which may include:

a) Translating the WETwin factsheets into French and printing of copies for large diffusion to stakeholder platforms, partner NGOs, Government institutions mainly in the IND region,

b) Preparing training materials for local use based on the WETwin deliverables, particularly the WP9 guidelines.

c) Elaborating a brochure that gives a summary of the scientific publications and other documents (Vulnerability of food production in the Inner Niger Delta to water resources management under climate variability and change, Health impact of wetlands management solutions for the IND, Mali , tec.). This brochure will be translated into French and two local languages (Bambara and Fulani) and printed for large diffusion.

The data collected in the frame of WETwin will be part of a joint database which is in course of construction by Wetlands International/ Mali and IUCN/Mali. These data will be also used as a contribution to the development of "Environmental information system of the IND". The latter is under development with a funding of IFAD under a project implemented by FODESA (Programme Fonds de Developpement en Zone Sahelienne). These databases will be accessible for public use and will be transferred to a governmental institution "Agence de l'Environnement pour un Developpement Durable" where it will be updated.

The sophisticated model-system initiated for the IND is recommended to be developed further and made available for supporting managers and local leaders in elaborating policies and emergency measures for preventing the breakouts of water-borne diseases. For this purpose the high-resolution DTM, that forms the basis of the model system, has to be developed further (see above).

Regarding the *Abras de Mantequilla wetland*, project results have been shared with local stakeholders in a series of meetings. At this moment local stakeholders are mainly focused on the plan for territorial organization of the wetland. We hope that project results will be considered as a source of valuable information for the plan of territorial organization. Given the interest of ESPOL to contribute to the development of integrated watershed management in Ecuador, acquired experience will be applied in other case studies implemented under national or international funding. Since agriculture represents probably one of the major stressors for the wetland, the research agenda is now being oriented towards the development of integrated alternative technologies for agriculture effluents treatment.

Studies performed on the *Lobau wetland* in the context of WETwin are shared in several other projects and will amongst others inform the Lobau Floodplain Reconnection project (funded by the Municipal Authority of Vienna) and a parallel project (MAB Project Lobau2020) on effects of increasing visitor numbers. The results will be integrated in future management plans. All data available for the Lobau case study have been integrated on project based database for the Lobau projects that is being developed. In addition to the Reconnection project and the MAB project, a new project has been submitted to analyse the development of the ecosystem services of the Lobau including a historical analyses and potential future changes considering global change scenarios (Ecodrivers Lobau). A second project that will study the effects of hydromorphological changes and changes in network configuration on the biodiversity of floodplains (WETECO) is also being developed.

Results for the *Nabajuzzi* and *Namatala* case studies in Uganda have been presented and discussed nationally and locally. The management objectives are being fed into the wetland management plans. WETwin reports moreover will be taken into account by the Ugandan Wetland Management Department in the review of national wetland management guidelines for local governments.

Work carried out within the frame of WETwin with regard to the *Gemenc wetland* is closely linked to the GEF Nutrient Reduction Project (TF 055 978). This project is funded jointly by the Hungarian Government and the Word Bank. VITUKI, the coordinator of WETwin, was a partner in the consortium of this GEF project. The objective of the GEF project is to elaborate and implement technical restoration measures for the Gemenc, with the aim of restoring the floodplain water bodies for the benefit of aquatic and semi-aquatic ecosystems and also for the benefit of nutrient retention. These interventions are implemented in the period of 2011-13. WETwin has assessed the vulnerability of the Gemenc floodplain to climate change, river bed incision and floodplain aggradation, by taking into consideration the impacts of restoration measures proposed by the GEF project. Our results will be delivered to the managers of the Gemenc wetland in order to support the adaptive management of this wetland during and after the implementation of the restoration measures.