Drivers – States – Impacts - Responses: DSIR analyses at the study sites

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Drivers – States – Impacts - Responses

DSIR analyses at the study sites

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1 Introduction

The primary objective of this document is to identify and explore the major environmental and livelihood problems (impacts) at the study sites, with special regard to those problems that are going to be dealt with within the WETwin project. Exploring problems involves the identification of the whole cause-effect mechanism from Drivers through State, to the Impacts. This document also aims at reviewing potential measures (Responses) proposed by various stakeholders and researchers, for mitigating the problems.
Relationships between Drivers, State, Impact and Responses have been analysed with the help of the DSIR methodology. DSIR supports the establishment of cause-effect relationships behind a given problem, and helps in screening measures with which the problem can be solved.
In WETwin 'Impacts' are interpreted as impacts on the Ecosystem Services of the wetland. Accordingly, DSIR analyses are preceded in this document by the identification of relevant Ecosystem Services. Classification of Ecosystem Services is carried out according to the systems given in the MEA (Millennium Ecosystem Assessment) (Finlayson et al., 2005) and TEEB (The Economics of Ecosystems & Biodiversity) (TEEB, 2010) projects.

Exploring cause-effect relationships contributes to Task 3.3: 'Qualitative description of natural status, drivers, pressures and functions', while screening measures supports Task 7.4: 'Identification of generic measures for improving wetland management' of the WETwin project (WETwin, 2008). The temporal dimensions of components of the DSI chains will also be analysed. It will be specified whether a given driver, state or impact characterises the present state or(/and) will emerge in the future. This will be an important contribution to Task 5.1: 'Initial vulnerability assessment for each case study'. It is important to state that at the prediction of future states of the various DSI elements, it was assumed that the envisaged measures (responses) are not implemented. Finally certain DSIR analyses concern institutional and administrative problems, which are contributions to WP4.

Based on the DSI analyses, *tradeoffs* between ecosystem services have also been identified and presented in this report.

2 Adaptation of the Ecosystem Services approach

In the DSIR analyses, 'Impacts' are interpreted as impacts on the 'Ecosystem Services' of the wetland.
Ecosystem Services are defined as the 'direct and indirect contributions of ecosystems to human well-being' (TEEB, 2010). The MEA and TEEB projects classify and describe Ecosystem Services in the following way:

Provisioning Services are ecosystem services that describe the material or energy outputs from ecosystems. They include food, water and other resources.	TEEB icons:
1. **Food**: Ecosystems provide the conditions for growing food. Food comes principally from managed agro-ecosystems but marine and freshwater systems or forests also provide food for human consumption. Wild foods from forests are often underestimated.	
2. **Raw materials**: Ecosystems provide a great diversity of materials for construction and fuel including wood, biofuels and plant oils that are directly derived from wild and cultivated plant species.	
3. **Fresh water**: Ecosystems play a vital role in the global hydrological cycle, as they regulate the flow and purification of water. Vegetation and forests influence the quantity of water available locally.	
4. **Medicinal resources**: Ecosystems and biodiversity provide many plants used as traditional medicines as well as providing the raw materials for the pharmaceutical industry. All ecosystems are a potential source of medicinal resources.	
Regulating Services are the services that ecosystems provide by acting as regulators eg regulating the quality of air and soil or by providing flood and disease control.	
5. **Local climate and air quality regulation**: Trees provide shade whilst forests influence rainfall and water availability both locally and regionally. Trees or other plants also play an important role in regulating air quality by removing pollutants from the atmosphere.	
6. **Carbon sequestration and storage**: Ecosystems regulate the global climate by storing and sequestering greenhouse gases. As trees and plants grow, they remove carbon dioxide from the atmosphere and effectively lock it away in their tissues. In this way forest ecosystems are carbon stores. Biodiversity also plays an important role by improving the capacity of ecosystems to adapt to the effects of climate change.	
7. **Moderation of extreme events**: Extreme weather events or natural hazards include floods, storms, tsunamis, avalanches and landslides. Ecosystems and living organisms create buffers against natural disasters, thereby preventing possible damage. For example, wetlands can soak up flood water whilst trees can stabilize slopes. Coral reefs and mangroves help protect coastlines from storm damage.	
8. **Waste-water treatment**: Ecosystems such as wetlands filter both human and animal waste and act as a natural buffer to the surrounding environment. Through the biological activity of microorganisms in the soil, most waste is broken down. Thereby pathogens (disease causing microbes) are eliminated, and the level of nutrients and pollution is reduced.	
9. **Erosion prevention and maintenance of soil fertility**: Soil erosion is a key factor in the process of land degradation and desertification. Vegetation cover provides a vital regulating service by preventing soil erosion. Soil fertility is essential for plant growth and agriculture and wellfunctioning ecosystems supply the soil with nutrients required to support plant growth.	
10. **Pollination**: Insects and wind pollinate plants and trees which is essential for the development of fruits, vegetables and seeds. Animal pollination is an ecosystem service mainly provided by insects but also by some birds and bats. Some 87 out of the 115 leading global food crops depend upon animal pollination including important cash crops such as cocoa and coffee.	
11. **Biological control**: Ecosystems are important for regulating pests and vector borne diseases that attack plants, animals and people. Ecosystems regulate pests and diseases through the activities of predators and parasites. Birds, bats, flies, wasps, frogs and fungi all act as natural controls.	

Habitat or Supporting Services underpin almost all other services. Ecosystems provide living spaces for plants or animals; they also maintain a diversity of different breeds of plants and animals.	
12. **Habitats for species**: Habitats provide everything that an individual plant or animal needs to survive: food; water; and shelter. Each ecosystem provides different habitats that can be essential for a species' lifecycle. Migratory species including birds, fish, mammals and insects all depend upon different ecosystems during their movements.	
13. **Maintenance of genetic diversity**: Genetic diversity is the variety of genes between and within species populations. Genetic diversity distinguishes different breeds or races from each other thus providing the basis for locally well-adapted cultivars and a gene pool for further developing commercial crops and livestock. Some habitats have an exceptionally high number of species which makes them more genetically diverse than others and are known as 'biodiversity hotspots'.	
Cultural Services include the non-material benefits people obtain from contact with ecosystems. They include aesthetic, spiritual and psychological benefits.	
14. **Recreation and mental and physical health**: Walking and playing sports in green space is not only a good form of physical exercise but also lets people relax. The role that green space plays in maintaining mental and physical health is increasingly being recognized, despite difficulties of measurement.	
15. **Tourism**: Ecosystems and biodiversity play an important role for many kinds of tourism which in turn provides considerable economic benefits and is a vital source of income for many countries. In 2008 global earnings from tourism summed up to US$ 944 billion (see Chapter 5). Cultural and eco-tourism can also educate people about the importance of biological diversity.	
16. **Aesthetic appreciation and inspiration for culture, art and design**: Language, knowledge and the natural environment have been intimately related throughout human history. Biodiversity, ecosystems and natural landscapes have been the source of inspiration for much of our art, culture and increasingly for science.	
17. **Spiritual experience and sense of place**: In many parts of the world natural features such as specific forests, caves or mountains are considered sacred or have a religious meaning. Nature is a common element of all major religions and traditional knowledge, and associated customs are important for creating a sense of belonging.	

Source: TEEB, 2010

The above described concept of Ecosystem Services has been adapted to the specific needs of the WETwin project. The major change we've made with regard to the original concept is that we've modified the definition. The new definition is that Ecosystem Services are *direct and indirect contributions of ecosystems to the well-being of humans **and Nature***. By this we want to avoid the pitfall that we see in the original Ecosystem Service approach. This pitfall is that the original ES approach takes Ecosystem Services into consideration only through their usefulness from the point of view of human well-being. It doesn't recognise ecosystem health, biodiversity, key species, nature(!) etc. as standalone values that we have to safeguard. These values are especially important in case of wetlands, and it is often the case that they have to be defended even against the interests of human well-being.
Habitat Services play a key role in the concept, since they support and underpin the other services and also they are essential contributions to the well being of the nature. Accordingly Habitat Services are treated as a separate subset of Ecosystem Services in case of each case study.

3 Application of the Drivers – States – Impacts - Responses (DSIR) Scheme

The evolution of a natural system subject to anthropogenic pressure is generally described by the Drivers – States – Impacts - Responses (DSIR) scheme (Figure 2-1). This methodology is based on the DPSIR approach developed by the European Environment Agency (EEA), cf. OECD (1994), UNCSD (1996). The idea is that Drivers alter the State of the system, and this alteration represents an Impact, i.e., an effect upon the environment and society (Becker, 2005). When the society is affected in an unfavourable way, it reacts by devising and implementing Responses that can target either the Drivers, the State, or directly the undesired or threatening Impacts, so that they are avoided, reduced, or compensated (Becker, 2005). This is represented in a simplified way in the DSIR scheme:

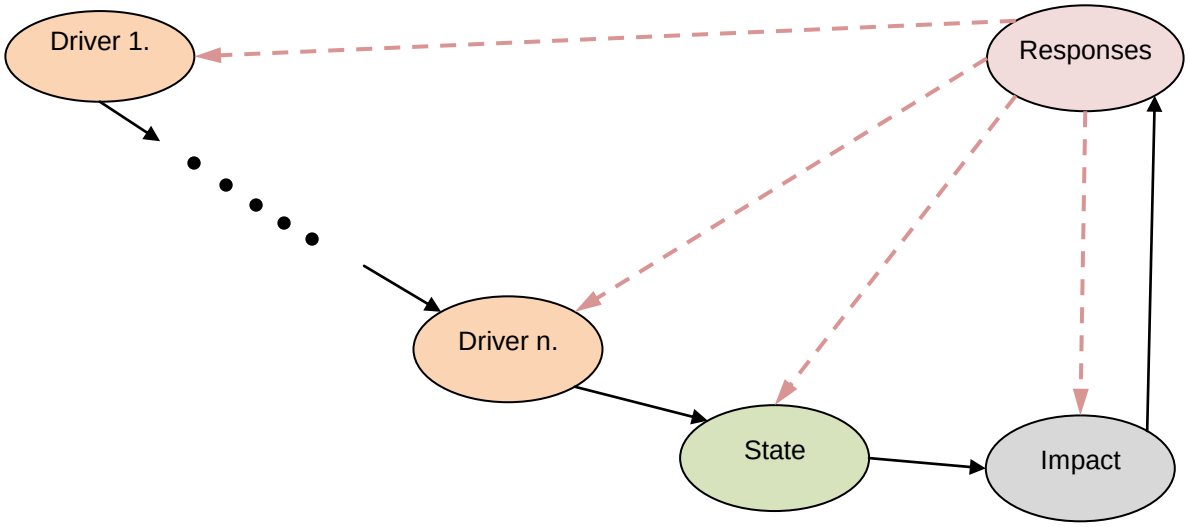


Figure 3-1: Basic form of the DSIR framework

An example prepared by Soncini-Sessa 2005 might be useful to further explain the methodology. Consider an idyllic lake, surrounded by grasslands, forests, a town inhabited by fishermen and small hotels used mainly by tourists. The baseline Drivers are the agricultural, industrial and civil practices producing nutrient (in particular, Nitrogen) flows (direct Drivers) reaching the lake via the surface or subsurface runoff from rural and agricultural land or from the urban drainage flows. The result of this is an undesired change of the State of the lake in terms of an increase of the trophic level of the lake that may lead to algal bloom, anoxic conditions or fish depletion. The change of State will ultimately result in Impacts such as a decrease of the fishing business and a loss of potential for local tourism.
To react to the discontent of fishermen and hotel owners, the Environmental Agency (EA) plans an intervention (Response). A Project is established to choose the response between different options such as: to issue a set of regulations about the usage of manure in the farming practice (responses targeting the baseline Drivers), to build a stage for the nitrogen removal within the waste water treatment plant for the upstream discharge (targeting the direct Drivers), to harvest the algae when necessary or to insufflate air at the bottom of the lake to prevent anoxic condition of the water (targeting the State), or simply to adopt a monetary compensation (targeting the Impacts) for the damage and associated economic losses.

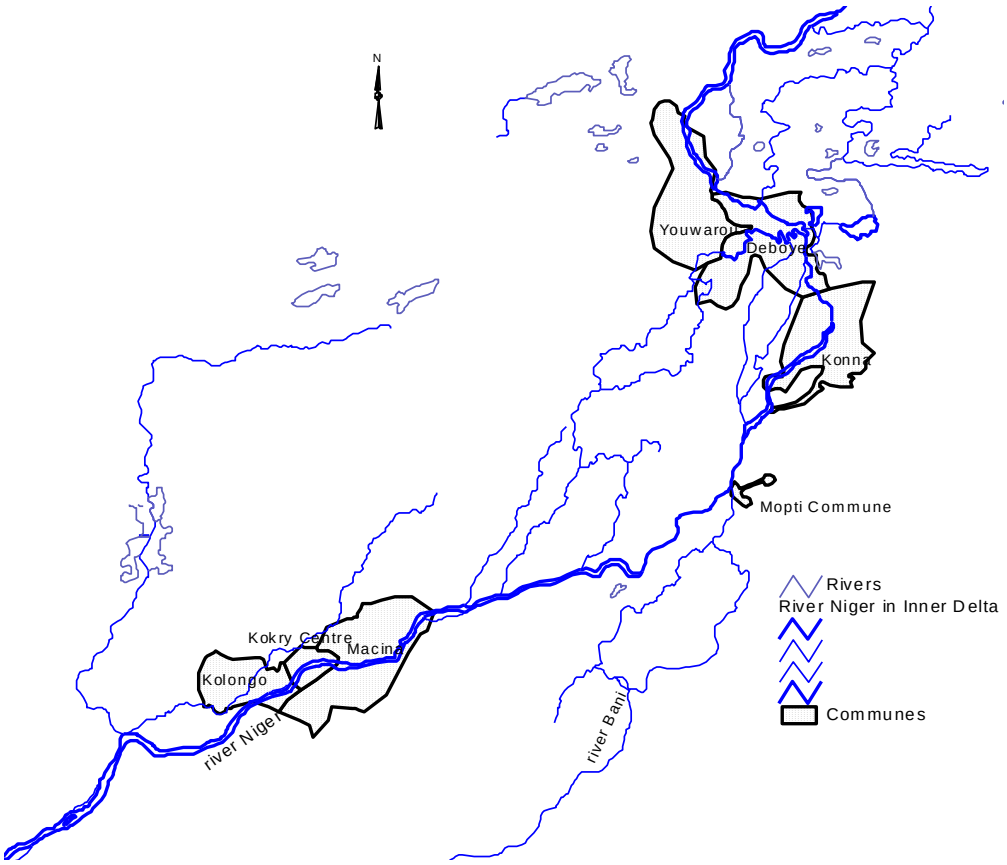
For the WETwin project elements of DSIR are defined in the following way:

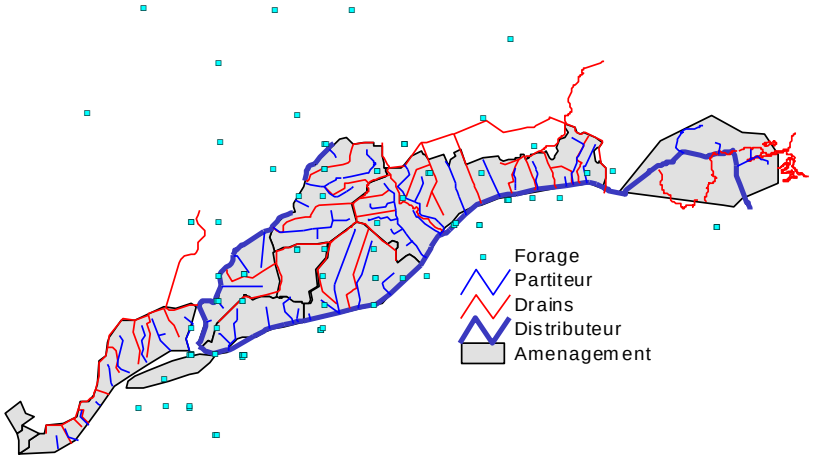
- **Drivers** are represented by natural and social processes which influence directly/indirectly the current/future environmental State. Drivers may act in the past, at present and also in the future. In this later case driving forces and their effects are called *vulnerability scenarios*.
- **State** describes physical, chemical or biological phenomena in the given reference area. It reflects the condition of the environment (Fondazione Eni Enrico Mattei, 2006). E.g. air, water, soil quality. Drivers cause *Changes of State* (e.g. decreased water levels, eutrophication) which ultimately result in *impacts*.
- **Impacts** on population, economy, ecosystems describe the ultimate effects of *changes of state*, in terms of damage (or benefit) caused to Ecosystem Services. E.g. biodiversity loss, reduced flood regulation capacity.
- **Responses** demonstrate the efforts of society (e.g. politicians, decision-makers) to solve the problems encountered in the investigated system (Fondazione Eni Enrico Mattei, 2006). E.g. policy measures.

4 DSIR analyses at the WETwin study sites

4.1 Inner Niger Delta

4.1.1 Delineation of the Macina, Mopti and Akka subsystems





4.1.2 Ecosystem Services of the Inner Niger Delta

4.1.2.1 Habitat Services

HABITATS	BIOTIC COMMUNITIES	TEEB icon	Flood season	Dry season
Flood forests as key habitats for colonially nesting waterbirds	Resident birds of the Delta such as herons, cormorants, darters, ibises and spoonbills		X	X
Flood forests as key habitats for fish: nesting birds fertilise the underlying water with their droppings, making these places prime areas for fish production	Fish stock of the Delta		X	
Floating bourgou (*Echinochloa stagnina*) fields as key feeding habitats for piscivorous bird species	Resident birds of the Delta, migratory Birds from Europe and adjacent Asia		X	X
Floating bourgou fields as key nursery habitats for juvenile fish providing both protection and food	Fish stock of the Delta		X	
Floating rice fields	Gene bank of local rice strains		X	X

Sources: Beintema et al., 2005; Zwarts et al., 2005

4.1.2.2 Regulating, Provisioning and Cultural Services

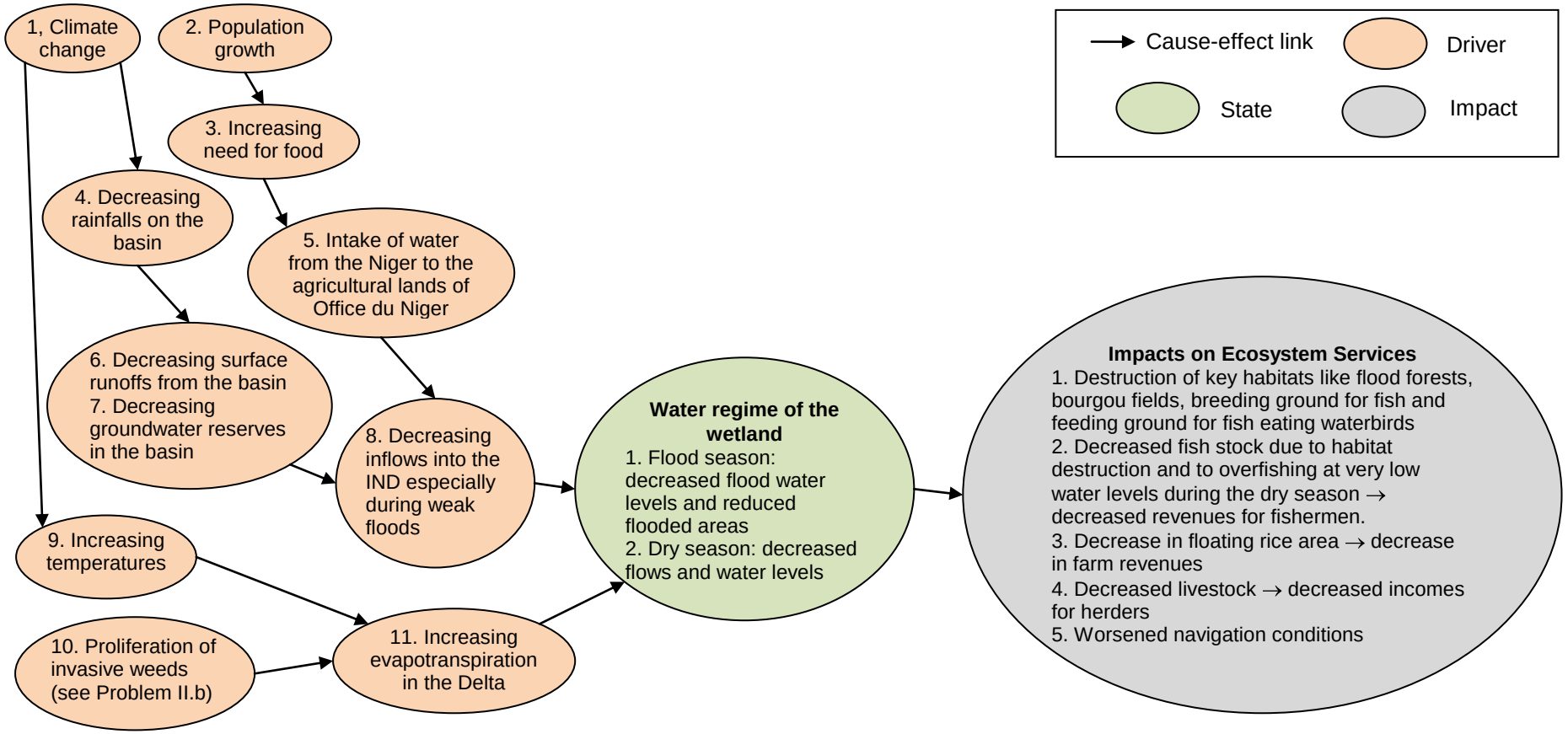
SERVICES			BENEFIT FOR:	TEEB icon	BENEFITS DURING	
					Flood season	Dry season
Regulating	Water quantity control: water regulation and flood control		Settlements in the Segou, Mopti and Tombouctou regions		X	
	Water quality control	Sediment retention: burial of nutrients in sediments deposited in the IND	Inhabitants and ecosystems in and downstream of the IND		X	
		Water purification and waste treatment	Inhabitants and ecosystems in and downstream of the IND		X	X
	Disease control	Control on water borne diseases: Diarrhea and Cholera	Inhabitants of the IND		X	X
		Control on vector borne diseases: Malaria and Schistosomiasis	Inhabitants of the IND		X	X
Provisioning	Food production	Rice production: irrigated and floating rice fields	Farmers (mainly Bambara and Rhimaibé people) living in the Delta		X	
		Bourgou production in the Delta	Herders (mainly Fulani people) who move their livestocks from pasture lands of the surroundings areas into the IND during receding flood and dry season, and have them grazed on the stranded bourgou			X
		Fish production in the Delta	Fishermen (mainly Bozo people) and fishing farmers living in the Delta		X	X
		Fodder for small ruminants as well as eggs and chicks provided by the flood forests	Inhabitants of the IND			X
	Water extracted from groundwaters, or directly from the surface waters for drinking, household and sanitation purposes (main source of water borne diseases)		Inhabitants of the IND		X	X
	Firewood and utility wood provided by the flood forests		Inhabitants of the IND			X

	SERVICES	BENEFIT FOR:	TEEB icon	BENEFITS DURING	
				Flood season	Dry season
	Plant species of different interest (medicinal, plague control,…..) provided by the flood forests	Inhabitants of the IND		X	X
	Navigation routes for transporting goods and people	Inhabitants of the IND		X	X
Cultural	Tourism and eco-tourism: supports preserving ecological and culture-historical values. The main tourist sites in the Delta are the regions of Mopti and Tombouctou.	Tourists visiting the IND. Hotels, restaurants, arts and craft centres in the Delta.		X	

Sources: Beintema et al., 2005; Berthe & Kone, 2008; Kuper et al., 2003; Zwarts et al., 2005

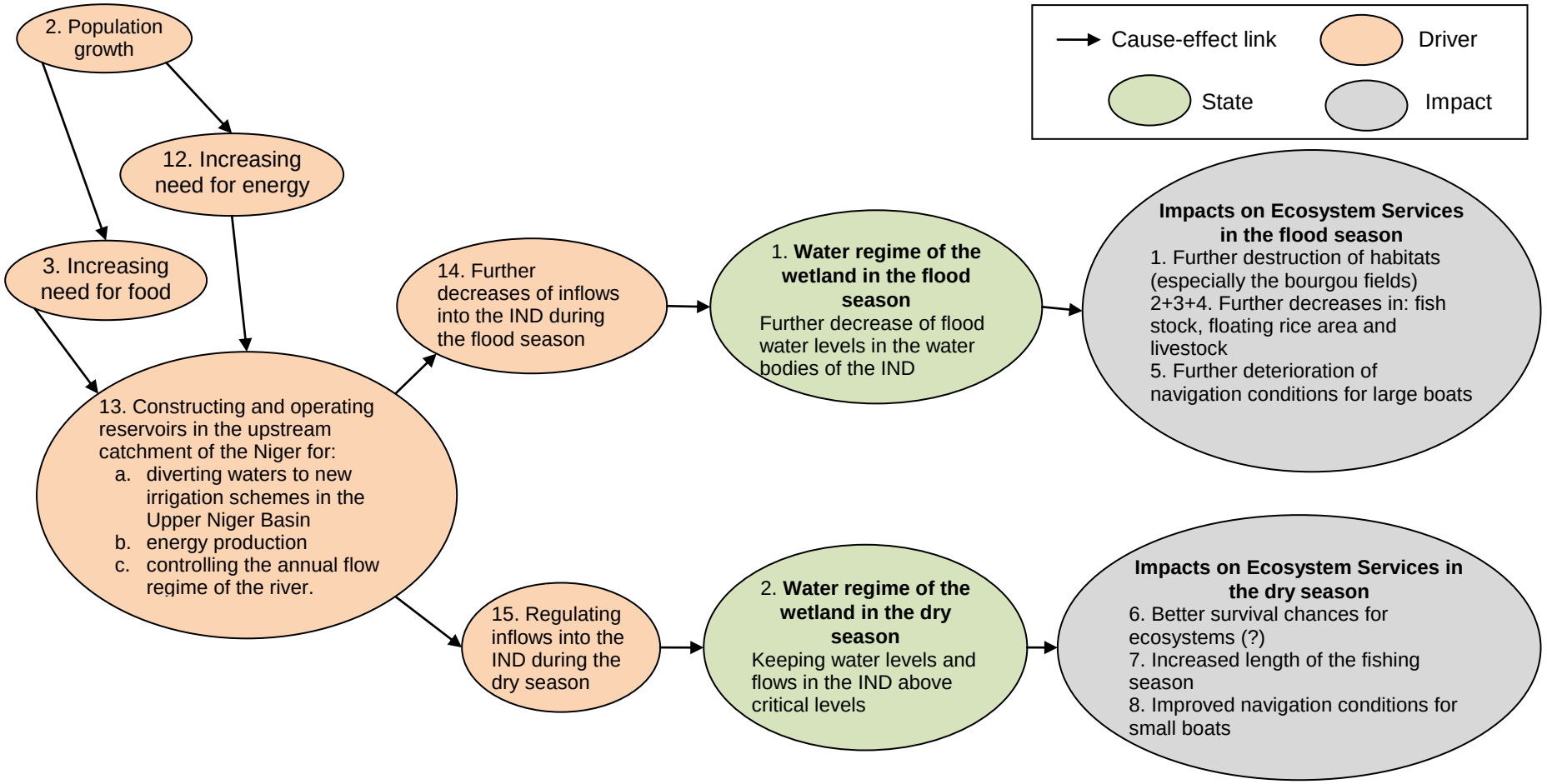
4.1.3 Problem I.: Changes to IND hydro-morphological regime

a. Impact of climate change and upstream water intakes by Office du Niger on the ecosystem services of IND (*without the effects of reservoirs built on the Upper Niger basin (e.g. the Sélingué reservoir built in 1982)*):



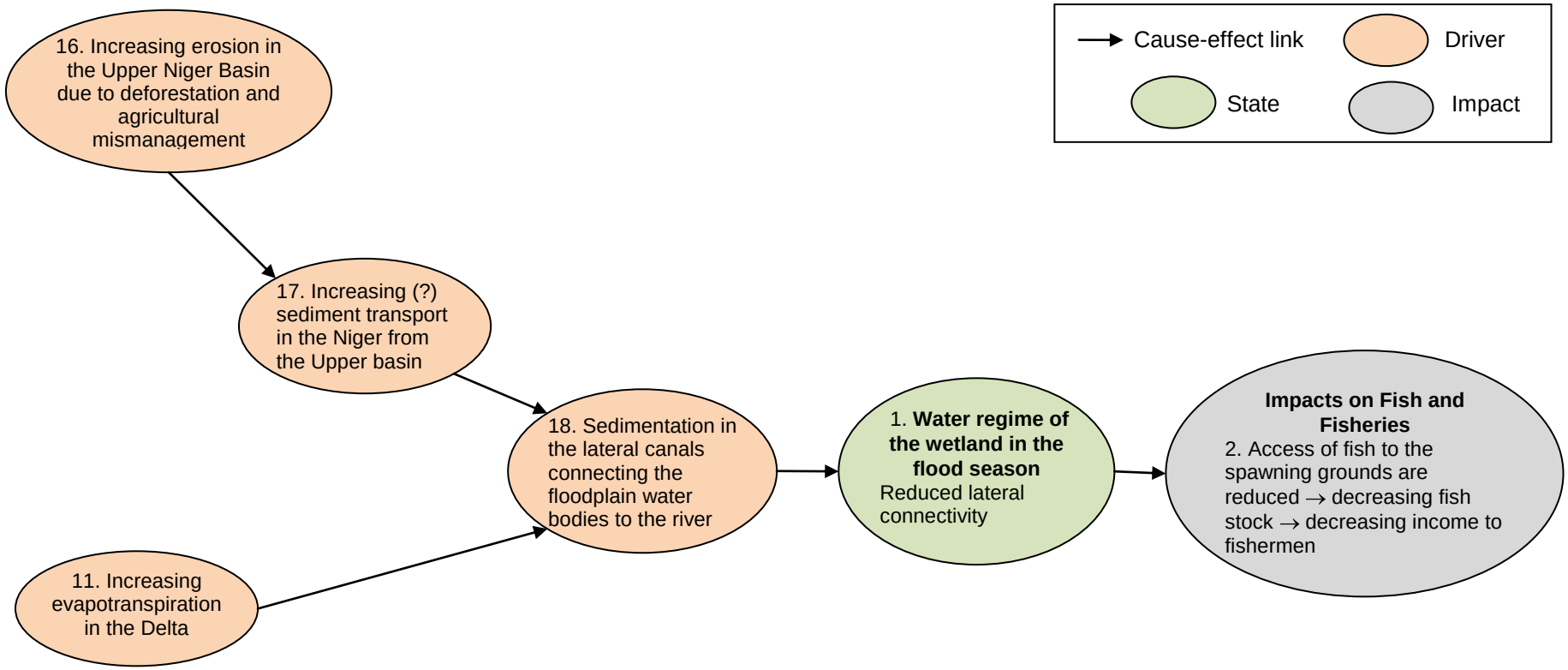
Sources: Berthe & Kone, 2008; Kuper et al., 2003; Oyebande et al., 2002; Zwarts et al., 2005

b. Impact of upstream reservoirs (existing reservoirs like the Sélingué and planned ones like the Fomi) on the ecosystem services of IND:



Sources: Kuper et al., 2003; Zwarts et al., 2005

c. Impact of sedimentation on the ecosystem services of IND:



Sources: WWF, 2008; Conclusions of the WETwin stakeholder meetings (27 November 2009, Konna, Mali)

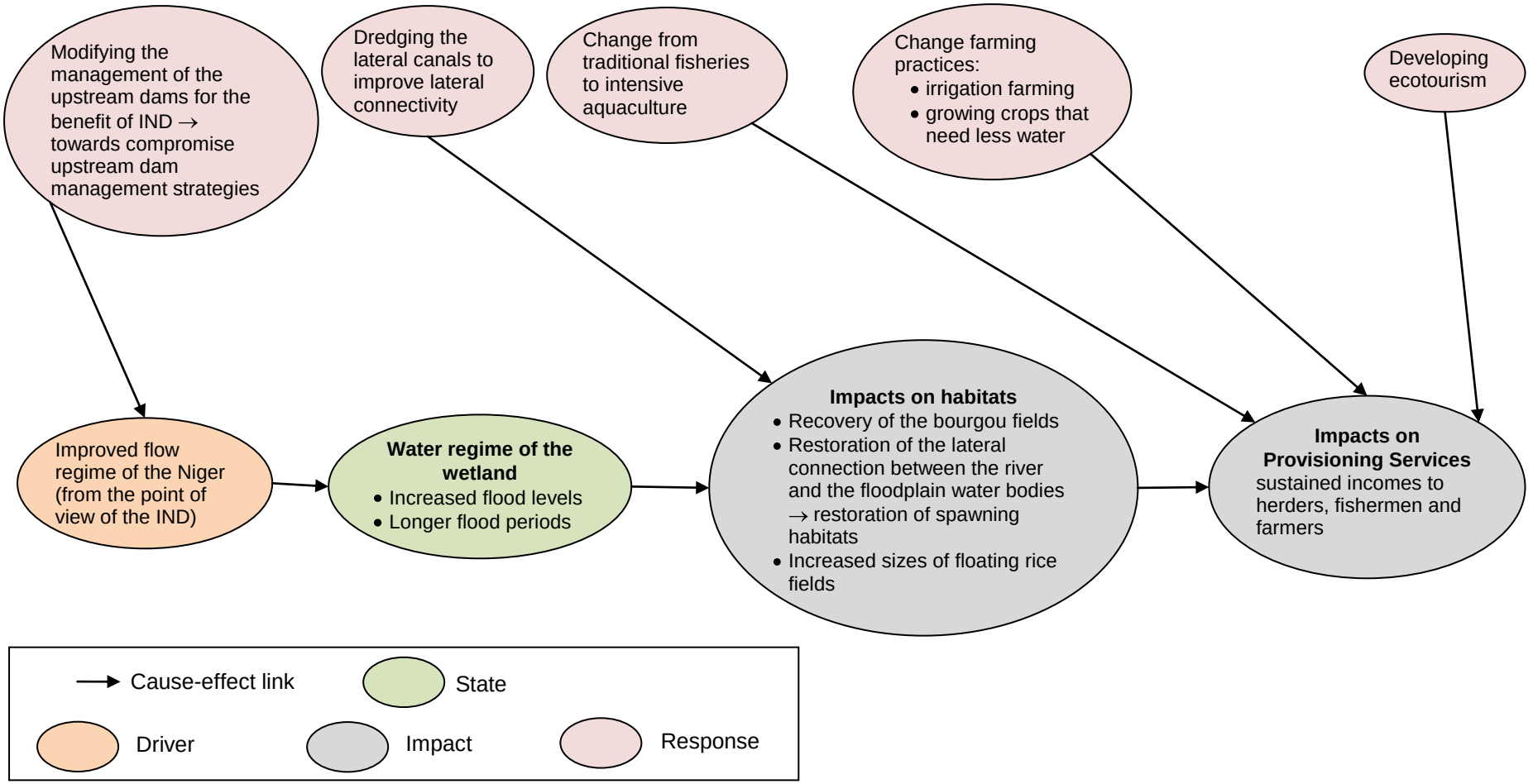
Detailed description of the DSI components:

DSI components		Spatial scales	Description	
			Present (+ near past)	**Future**
Drivers	Population growth	countries of Mali and Guinee	The total population of Mali is 11,965,788 (data from 2004), of which 1 million inhabit the Inner Niger Delta. The actual rate of annual population growth is 2.6%	
	Decreasing rainfalls on the basin	Upper Niger Basin	Since 1973 the Sahel has been confronted with a decline in rainfall. The trend is -3.5 mm/y on the Upper Niger basin.	In spite of the inconsistency of model prediction, precipitations are likely to decrease in most parts of West and Central Africa. It is assumed that the trend of -3.5 mm/y will continue.
	Increasing temperatures	West Africa	Observed records show that the African continent is warmer than it was 100 years ago and the warming rate during the 20th century was about 0.05°C per decade.	Land areas may warm by as much as 1.6°C by 2050 over the Sahara and the surrounding semi-arid areas.
	Intake of water from the Niger to the agricultural lands of Office du Niger	Office du Niger right upstream of IND	Office du Niger is operational since 1947. Nowadays 70 000 ha of the rice fields are irrigated. The annual water intake from the Niger is 2. km³ (80 m³/s). Gravitational intake is enabled by the Markala dam built on the Niger.	There are plans for extending the irrigated area by about 13700 ha in the coming years. The master plan of the scheme envisages ultimately an irrigation infrastructure for over 250000 ha.
	Constructing reservoirs in the upstream catchment of the Niger	Upper Niger basin	The Sélingué reservoir (2.04 km³/year) is operational since1982.	Planned reservoir at Fomi with 6.2 km³ /year and 30000 ha of irrigated area. Planned reservoirs at Talo and Djenné
	Decreasing inflows into the IND	Inner Niger Delta	Started in 1973 with the declining rainfalls (eighties: 'La Grande Sécheresse'). Further decreases during the flood season due to retentions in the Sélingué reservoir	Further decreases are expected due to: climate change, enlargement of Office du Niger, construction of reservoirs upstream (this later will cause decreases only during the flood season)
	Increasing evapotranspiration in the Delta	Inner Niger Delta	Evaporation/transpiration and temperature variability are closely related. Increases in temperature have implied an increase in open water and soil/plant evaporation.	As a rough estimate, potential evapotranspiration over Africa is projected to increase by 5–10% by 2050.
	Regulating inflows into the IND during the dry season	Inner Niger Delta	Releases from the Sélingué reservoir add to the base discharge of the Upper Niger, though a large portion of these waters is diverted to Office du Niger. Nevertheless, in May (when the natural river flow can be as low as 40 m^3/s) the inflows to the IND are kept above 50-60 m^3/s with the help of Sélingué dam (in spite of the intakes by Office du Niger).	The planned reservoirs upstream will result in further increases in dry season flows, given that no significant increases in water intakes to Office du Niger will take place. Otherwise: dry season inflows may even decrease in the future due to the combined effects of climate change and water uses.

DSI components		Spatial scales	Description	
			Present (+ near past)	**Future**
State	Water levels and flooded area in the IND during the flood season	Inner Niger Delta	A water balance model revealed that the water level in the Delta from August to October is on average 5-10 cm lower due to irrigation of the Office du Niger zone and another 15 cm lower due to the Sélingué reservoir. Sélingué reservoir has lead to an average decline of the maximum inundated area of 600 km^2. Water intake by the Office du Niger has caused an additional decline of 300 km^2.	The Fomi dam will reduce the peak flood level by another 45 cm and it will cause an additional decline of 2200 km^2 in the max inundated area.
	Water levels and flows in the IND during the dry season	Inner Niger Delta	no data	no data
Impact	Impact on habitats	Inner Niger Delta	As a result of decreased flood levels, the sizes of bourgou fields (*Echinochloa stagnina*) and flood forests have decreased.	The Fomi dam is expected to reduce the extent of floating bourgou fields by 62% relative to the present situation.
	Impact on fish stock and on revenues for fishermen	Inner Niger Delta	According to fishermen fish catches have significantly reduced in size in the last 30 to 40 years. Fish trade in the IND would be 6% higher in the absence of the Office du Niger and an additional 13% higher without Sélingué.	Analysis predicts that current fish trade will be reduced by 37% if the Fomi dam is constructed.
	Impact on rice production and on farm revenues	Inner Niger Delta	Farmers on average produce 4300 tonnes less (4.9%) floating rice as a result of Sélingué. Without Office du Niger, floating rice production in the Delta would be 8900 tonnes greater (10.4%) (In contrast to decreasing rice production in the Delta, rice production at the upstream irrigation fields (OdN) has increased significantly)	The Fomi dam would significantly reduce food security in the Delta by decreasing rice production with 34500 tonnes (40%).
	Impact on livestock	Inner Niger Delta	The size of livestock has been decreased due to the degradation of the pastures (overgrazing) and the bourgou	Livestock will likely be damaged further
	Impact on navigation conditions	Inner Niger Delta	Reduced operation season for large boats due to lowered water levels in the flood season. Increased number of operation days available for small boats thanks to increased dry season water levels	Further reduction in the operation season of large boats during the flood season due to the reduced flood levels. Further extension of operation season of boats during the dry season due to increased water levels.

Sources: Kuper et al., 2003; Oyebande et al., 2002; Wong et al., 2005a; Zwarts et al., 2005

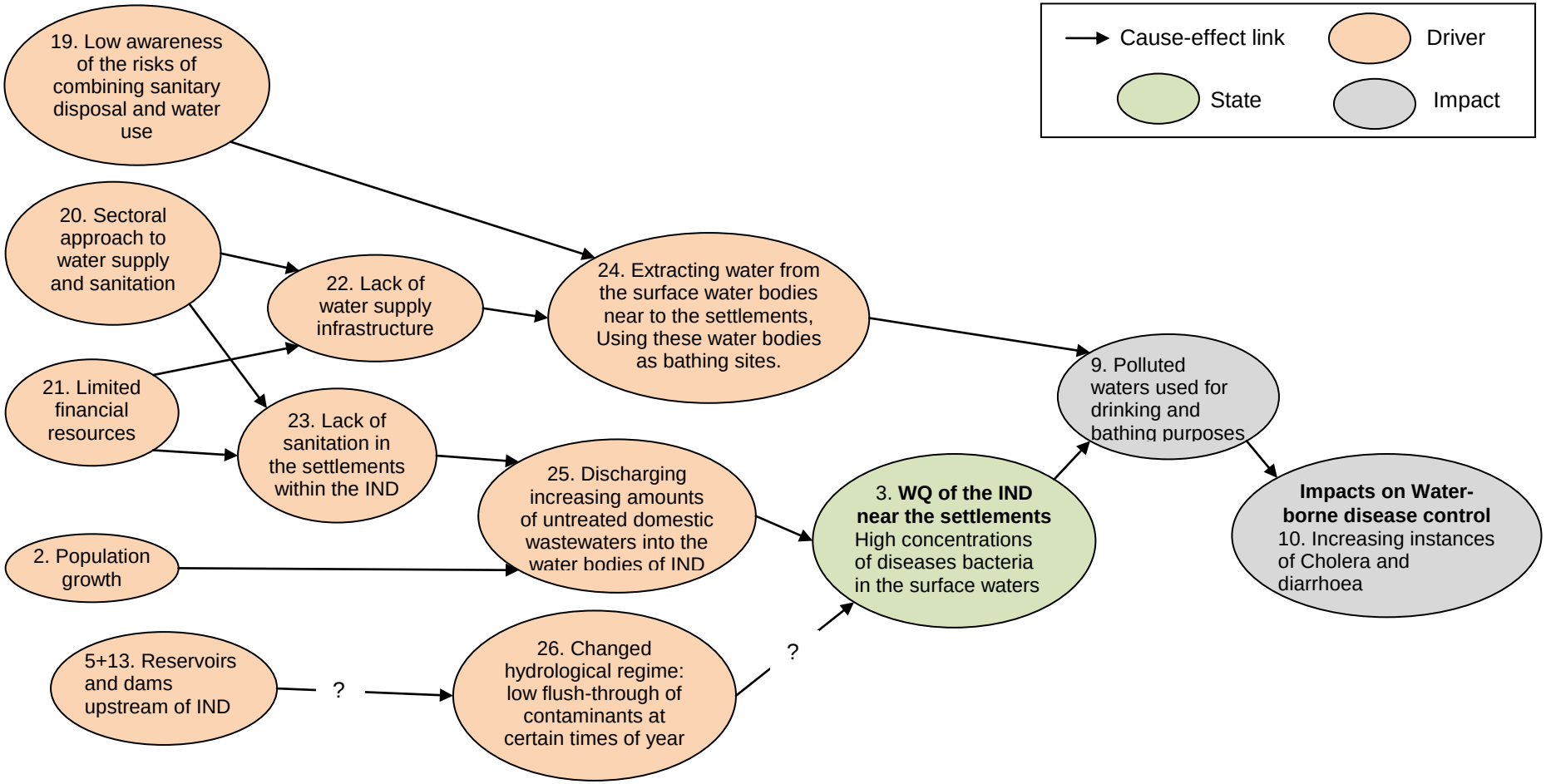
Potential measures (responses) for improving the provisioning services of IND; expected impacts of these measures:



Sources: Conclusions of the WETwin consortium and stakeholder meetings (November 2009, Mali)

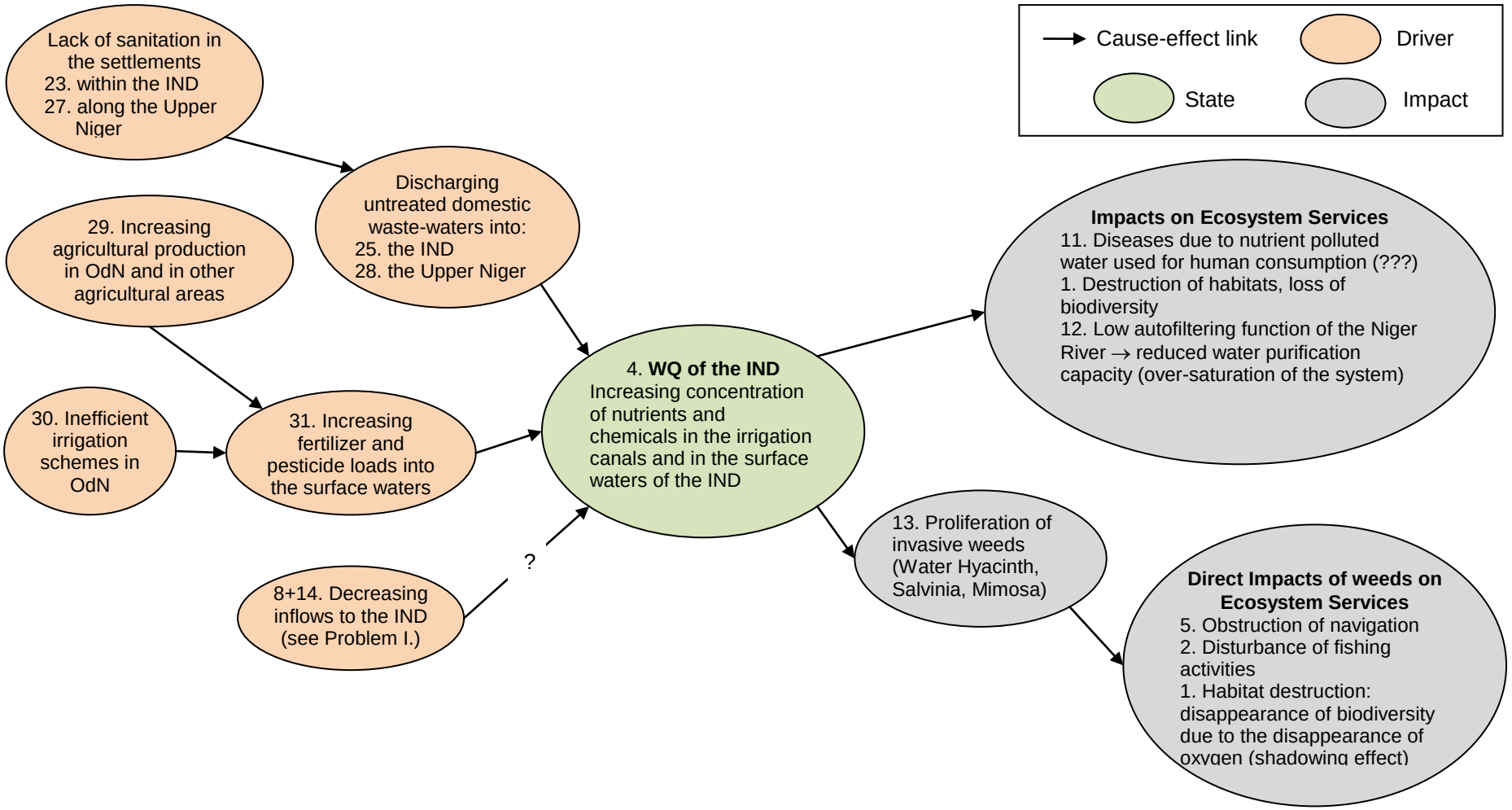
4.1.4 Problem II.: Domestic and agricultural pollution of surface waters

a. Problem of water-borne diseases:



Sources: Berthe & Kone, 2008; information from C. Baker and B. Kone

b. Problem of nutrient and chemical pollution:



Sources: Berthe & Kone, 2008; Conclusions of the WETwin consortium and stakeholder meetings (November 2009, Mali)

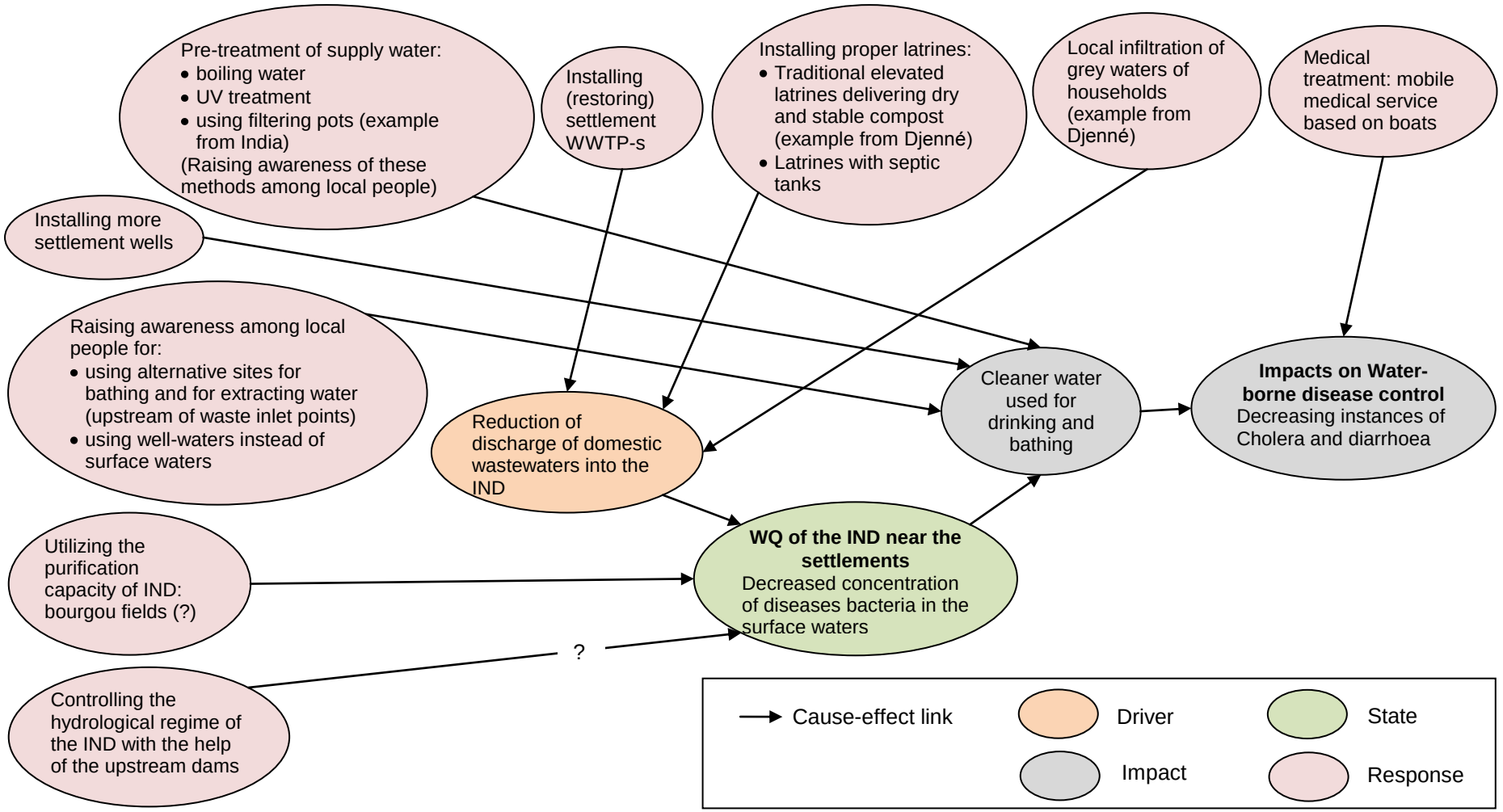
Detailed description of the DSI components:

DSI components		Spatial scales	Description	
			Present (+ near past)	**Future**
Drivers	Lack of sanitation in the settlements	Settlements in and around the IND, settlements along the Niger upstream of IND	49% of the population of Mali has access to potable water. 31% of the country's population does not have access to improved sanitation. 23% of households of Mali do not have toilet of any kind. In the rural areas 30% of households do not have any form of latrine. Lack of settlement WWTP-s: the WWTP of Mopti broke down 2 (?) years ago. Other settlements in the IND don't have WWTP-s at all.	The current situation will improve with the new policy on sanitation and its action plan adopted by the Malian Government in 2008. Also, in the IND they are many projects dealing with the issues which foresee a better situation in the future
	Extracting surface waters for drinking and household purposes	Settlements in the IND	Around 5% of the country's households draw water from rivers, streams or ponds. In the IND, the proportion of households with access to tap water is 32%. Drinking water is a rare commodity for the inhabitants of the area in particular, with 96 functional boreholes in 1998.	This situation has its root in the culture of the IND communities. But it could be improve by making available more improved boreholes and awareness programs.
	Discharging untreated domestic waste-waters into the Niger river	Settlements in and around the IND, settlements along the Niger upstream of IND	Domestic wastewater is poured into the street, into badly designed gutters and sumps. Barely 8.3% of the population of Mali has a cesspool for the disposal of domestic wastewater. Thus, most of wastewaters discharge directly into the ground- and surface water bodies.	The situation will unlikely to change in the near future
	Fertilizer and pesticide loads into the Niger	Agricultural lands in and around the IND, and along the upstream Niger	Respectively 59 716 , 62 231, 68 880, 87 466 and 106 455 t of fertilizers have been used around and along the upstream Niger Respectively 1 366 000, 1 080 000, 1 310 000, 2 102 460 and 1 600 445 litres of insecticides have used in1995, 96, 97 , 98 and 2003 Respectively 125 000, 169 000, 210 000, 497 010 and 243 185 litres of herbicides have been used 1995, 96, 97, 98 and 2003.	The situation will be worsened with the expected increase of the irrigated areas of Office du Niger and subvention given to famers on rice fertilizers
State	High concentrations of diseases bacteria in the surface waters	Waters around and downstream of settlements within the IND	Information about bacterial concentrations in these waters	Prognoses for future
	Increasing concentration of nutrients and chemicals in the surface- and	IND	Actual concentrations of key nutrients at three characteristic sites of the IND: Macina: nitrate: 3.2 – 29.8 mg/l; nitrite: 0.007 – 0.034 mg/l Mopti: nitrate: 3.3 – 14.6 mg/l; nitrite: 0.001 – 0.074 mg/l Youwarou: nitrate: 2.3 – 39.6 mg/l; nitrite: 0.002 – 0.063 mg/l	Prognoses for future

DSI components		Spatial scales	Description	
			Present (+ near past)	**Future**
	groundwaters of the IND.		These values are all bellow the drinking water limits of the WHO (50 mg/l for nitrate, 3 mg/l (short term exposure) and 0.2 mg/l (long term exposure) for nitrite)	
Impact	Polluted waters used for drinking and bathing purposes	Settlements in the IND	WQ data of surface waters used for drinking and bathing purposes in the IND	The current situation will improve because of many projects and programs intervening on these issues.
	Proliferation of invasive weeds (Water Hyacinth, Salvinia, Mimosa)	IND and Office du Niger	The main weeds covering Office Niger and some parts of the IND are: *Eichornia crassipes*, *Pistia stratiotes*, *Vossia cuspidasta* and *Salivinia molesta*. *Eichornia crassipes* and *Salivinia molesta* are the main constraint of the irrigation scheme of Office Niger. All channels are covered.. *Vossia cuspidate* are present all over the IND and it is main competitor of the *Echinochloa stagnina* (bourgou) pastures. *Pistia stratiotes* is scattered inside the IND mainly it could be found in existing flooded forests such as Dentaka, Akkagoun, etc.	According to the Director of Office du Niger (2009): "if solutions will not be found to eradicate these weeds Office du Niger will disappear in near future". This proof how the problem of weeds at Office du Niger is alarming
	Diseases due to nutrient polluted water used for human consumption (??)	Settlements in the IND	According to international standards the nutrient content of the water of the Niger river is above the health threshold (??????)	
	Impacts on Water-borne diseases: Increasing instances of Cholera and diarrhoea	Settlements in the IND (e.g. Mopti, Konna)	During the hot season (April to June), there is a resurgence of cholera, particularly, in the Mopti Region, which is most dependent on the Niger River. The national prevalence rate of diarrhoea is 19% among children under 5 years, and 29% among children aged 6-11 months. The correlation between the access to safe drinking water and the instances of diarrhoea is indicated by the fact that 14% of children living in households with access to tap water contracted the disease compared to 27% of children living in households using water from backwaters.	The current situation has already and will continue to improve because of the national program on: each Malian village must at least an improved drilling or improved boreholes.

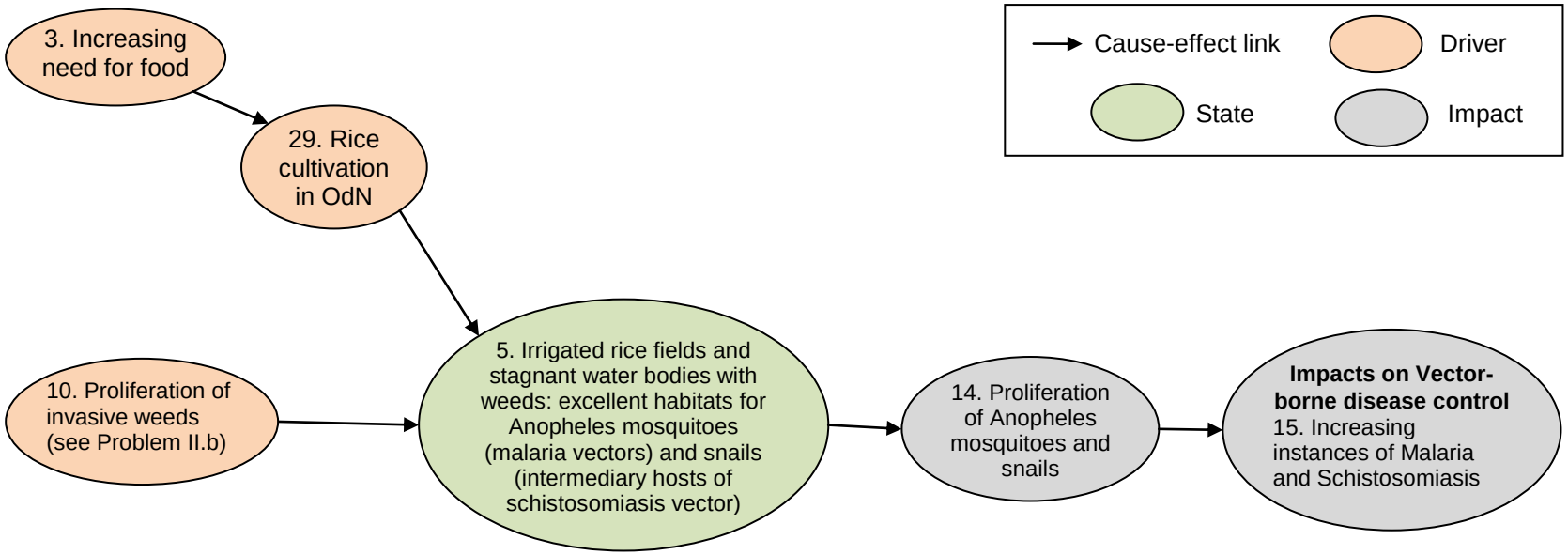
Sources: Berthe & Kone, 2008; Wong et al., 2005; information from B. Kone; LNE, 2009; WHO 2008.

Potential measures (responses) for controlling water-borne diseases; expected impacts of these measures:



Sources: Alderlieste & Langeveld, 2005; WI project: 'Poverty Reduction in the Inner Niger Delta of Mali' (report title?); Conclusions of the WETwin consortium and stakeholder meetings (November 2009, Mali)

4.1.5 Problem III.: Vector-borne diseases



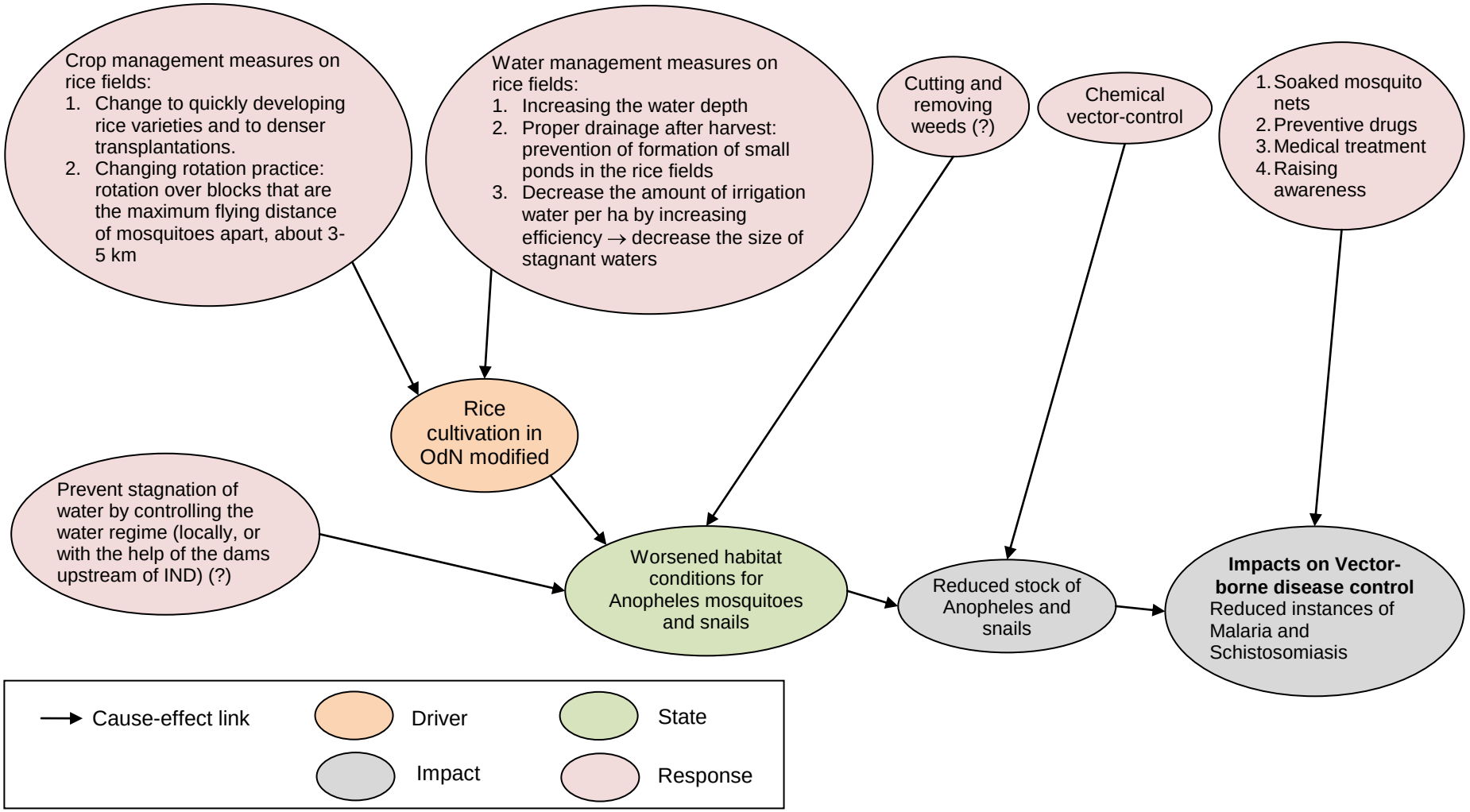
Sources: Berthe & Kone, 2008; Klinkenberg et al., 2002

Detailed description of the DSI components:

DSI components		Spatial scales	Description	
			Present (+ near past)	**Future**
State	Irrigated rice fields and stagnant water bodies with weeds as habitats for Anopheles mosquitoes and snails	Office du Niger	Nowadays 70 000 ha of the rice fields are irrigated in OdN.	Irrigated areas in the OdN are planned to be extended by about 13700 ha in the coming years. The master plan of the scheme envisages ultimately an irrigation infrastructure for over 250000 ha.
Impact	Proliferation of Anopheles mosquitoes and snails	Irrigation fields and channels in Office du Niger	Mosquitos are present all over the IND, even though Anopheles are likely to be concentrated around the irrigated rice fields as malaria cases have been reported from these regions first of all. Malaria is not a significant threat for people living far away from the irrigation schemes (e.g. in Mopti) Snails, intermediary hosts of Schistosomiasis, are present all over irrigated rice field zones.	Without more prevention measures, they will continue to cause more mortality and morbidity.
Impact	Impacts on Vector-borne diseases: Increasing instances of Malaria and Schistosomiasis	Settlements in the vicinity of Office du Niger	Malaria is the main cause of general morbidity and mortality in Mali among children under five years of age. Among children aged 0-5 years, 80-90% may carry the malaria parasite during the rainy season. Regarding Schistosomiasis, it is estimated that 2.5 million people in Mali are infested. 93.3% of the villages in the Office du Niger and 66.7% of the riparian population of the River Niger have at least 51% of their children infected by *S. haematoblum*, which is the most widespread of the Schistosomiasis.	Even though there are national plans for treating and preventing these diseases , involvement of local communities and local policymakers in defining, planning and implementing might improve the current situation

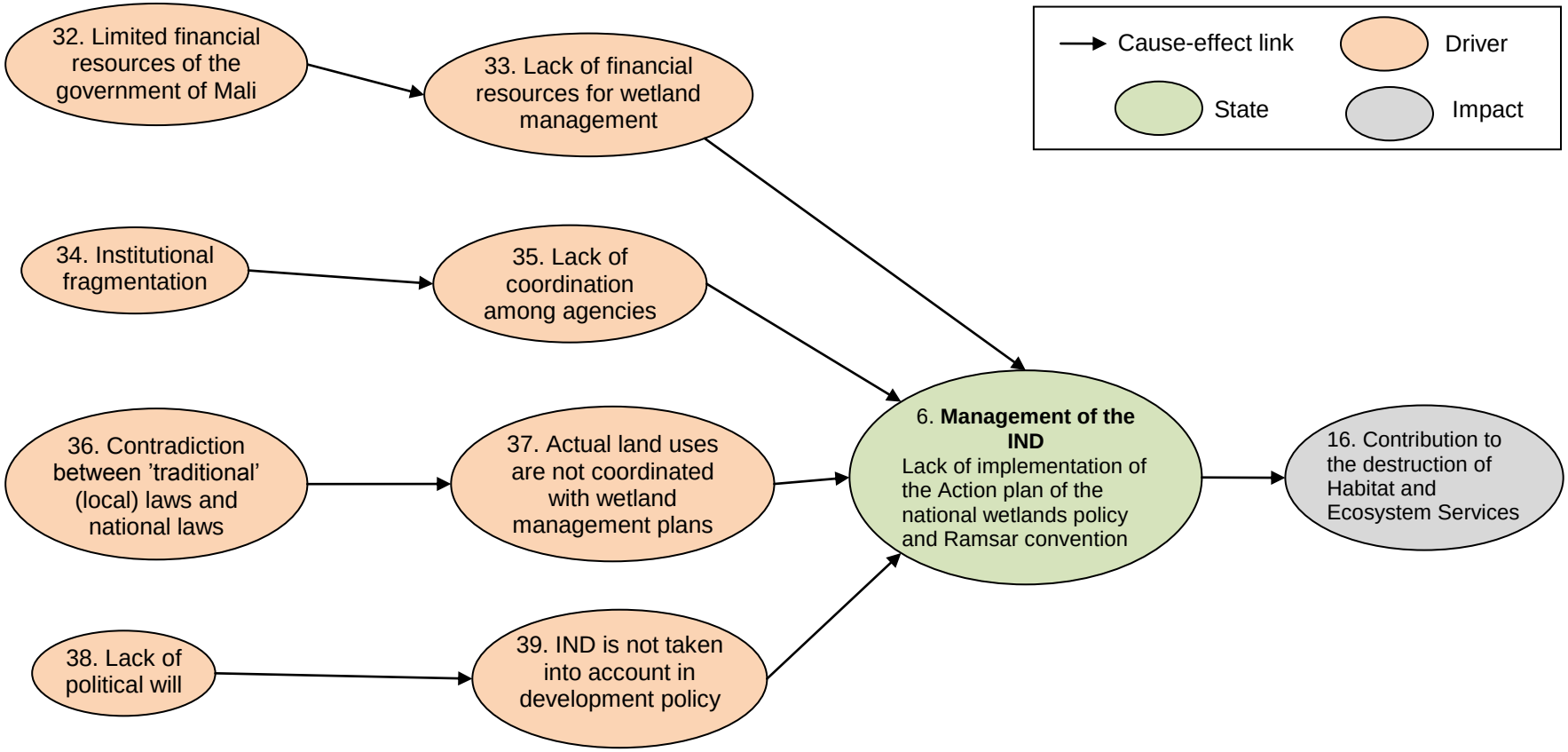
Sources: Berthe & Kone, 2008; information from B. Kone

Potential measures (responses) for controlling vector-borne diseases; expected impacts of these measures:



Sources: Berthe & Kone, 2008; Klinkenberg et al., 2002; information from C. Baker

4.1.6 Problem IV.: Management problems in the Inner Niger Delta



Source: Information from B. Kone

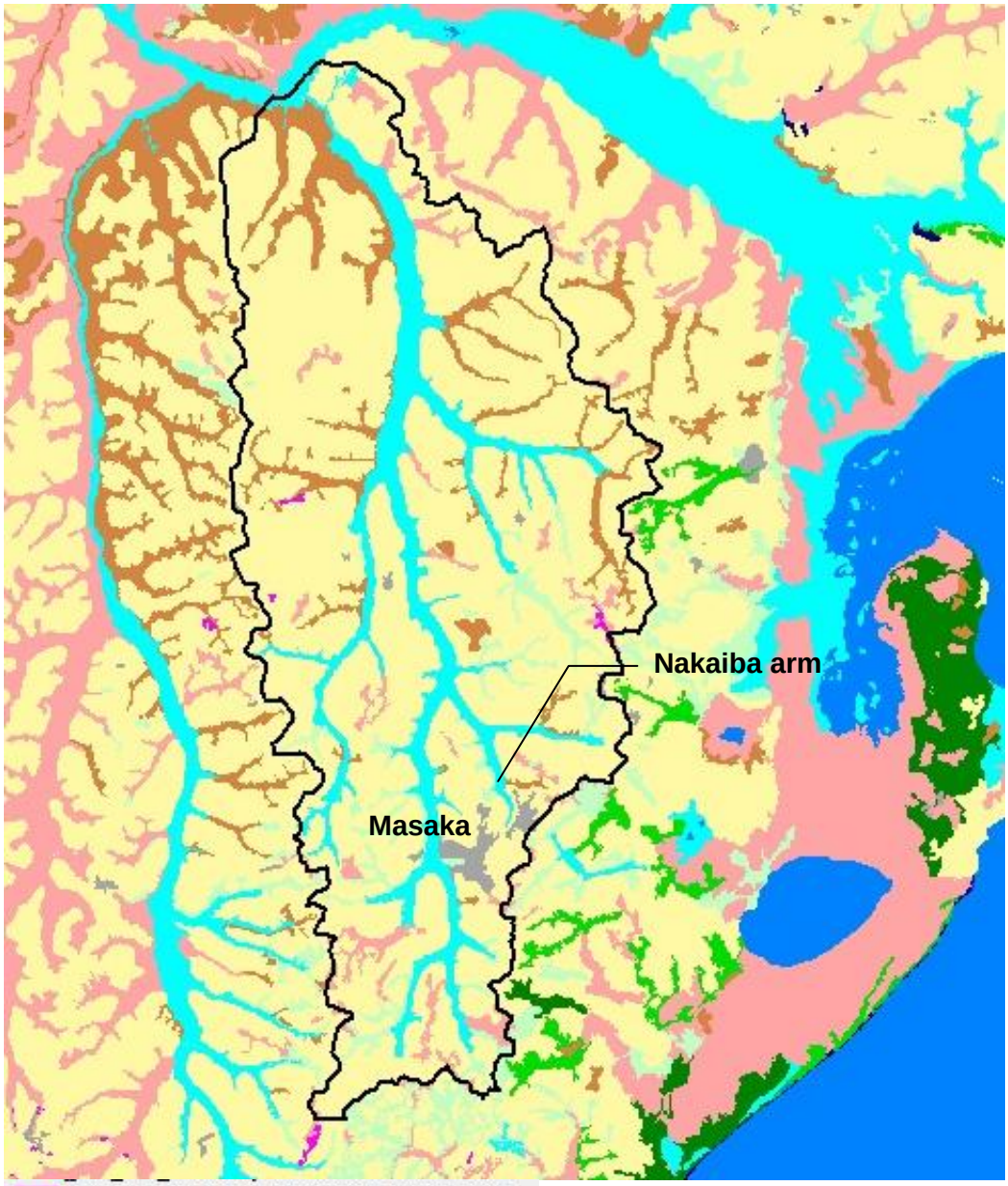
4.1.7 Identification of tradeoffs between ecosystem services

Water management for food and energy production upstream: management of the Markala (Office du Niger), Selungé and Fomi dams under regional scenarios	↔	Food production (floating rice, fish, cattle) in the Delta
Food production in Office du Niger (dam and irrigation management)	↔	Disease control: vector-borne diseases in the Macina region (Schistosomiasis, malaria)
Food production in Office du Niger and in other agricultural lands upstream of IND → fertilizer and pesticide pollution of the Niger	↔	Quality of water in the Macina region for drinking. Invasive weeds in the canals and water bodies in the Macina region. Ecosystem health of the IND.
Human waste disposal from the settlements into the surface waters of the IND	↔	Quality of waters in the IND used for drinking and bathing purposes (Mopti, Konna) → water-borne diseases

Source: Conclusions of the WETwin consortium and stakeholder meetings (November 2009, Mali)

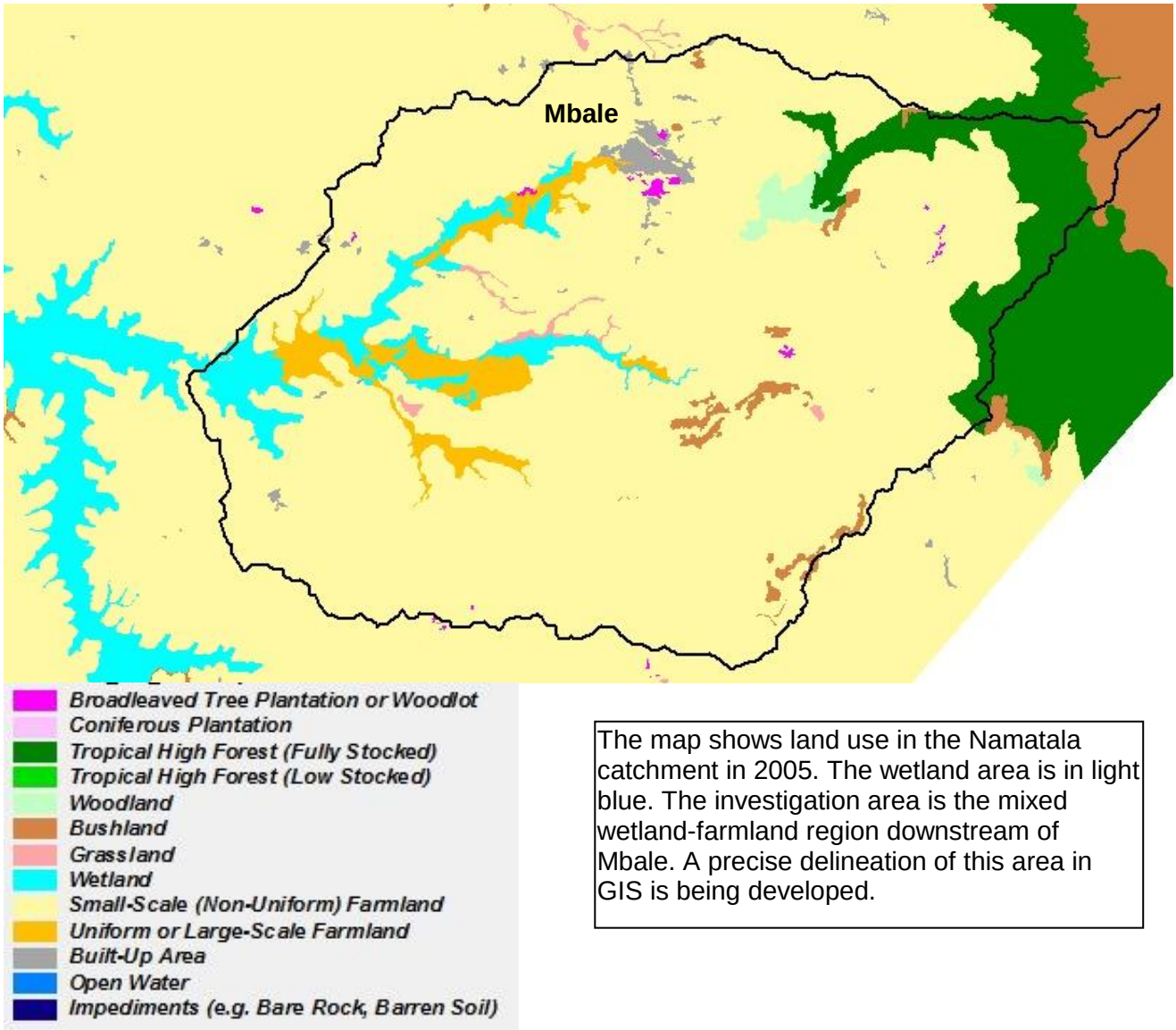
4.2 Nabajjuzi and Namatala wetlands

4.2.1 Delineation of the Nabajjuzi catchment and wetland



The map shows land use in the Nabajjuzi catchment in 2005. The wetland area is in light blue. Primary investigation area consists of the wetland branches upstream from Masaka. Secondary investigation area consists of the two wetland branches downstream from Masaka down to their junction. A precise delineation of these two areas in GIS is being developed.

4.2.2 Delineation of the Namatala catchment and wetland



The map shows land use in the Namatala catchment in 2005. The wetland area is in light blue. The investigation area is the mixed wetland-farmland region downstream of Mbale. A precise delineation of this area in GIS is being developed.

4.2.3 Ecosystem Services of the Nabajjuzi and Namatala wetlands

4.2.3.1 Habitat Services

HABITATS	BIOTIC COMMUNITIES	TEEB icon
Habitats for natural aquatic plants.	*Cyperus papyrus* L. (the dominating aquatic plant), phoenix. (In Namatala these natural plants have been replaced by rice at most places, only few natural wetland spots have been left. Most part of Nabajjuzi is still under natural vegetation cover, though agricultural encroachment is in progress.)	
Habitats for terrestrial plants	Palm trees, sedges	
Habitats for rare native mammals (only Nabajjuzi)	e.g. Sitatunga (~antelope)	
Spawning, nursery and feeding habitats for various fish species	Fish stock of the wetland; fish stock of the Katonga River: Lung Fish, Mud Fish	
Habitats for insects	e.g. Enswa (~termite)	
Nesting, resting and feeding habitats for birds.	Bird community of the wetland and of the region. Migratory birds from other regions and continents. In the Nabajjuzi over 200 species of bird have been recorded including the Shoebills, Papyrus Yellow Warbler, Papyrus Gonolek, Saddle-billed Stork, Crowned Cranes and occasionally Woolly-necked Stork.	
Highly dynamic area due to water abundance and soil fertility	All wetland communities	

Sources: MWLE, 2004; information from L. Iyango and R. Kaggwa; presentation of S. Namaalwa in the Mali project meeting; NatureUganda, 2008

4.2.3.2 Regulating, Provisioning and Cultural Services

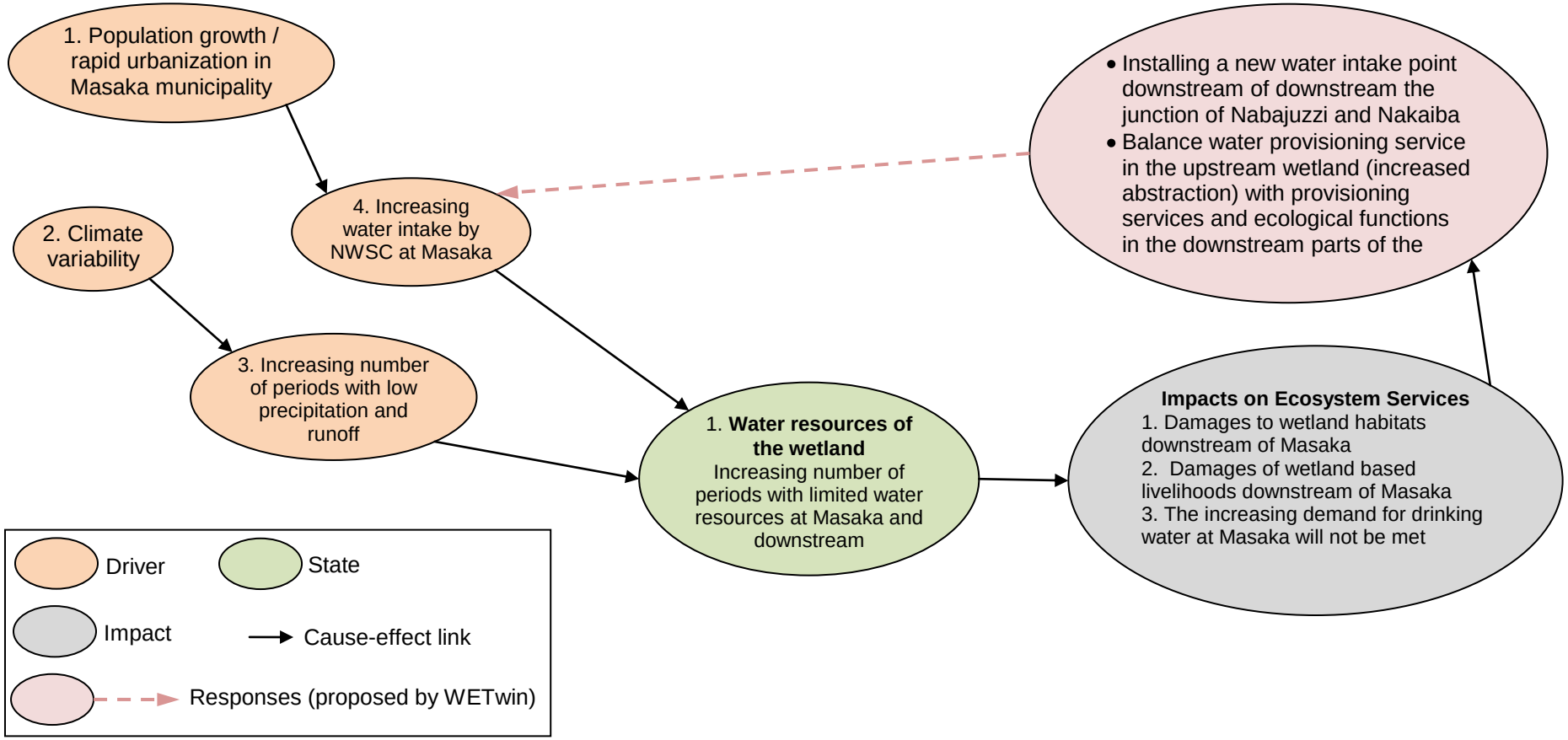
SERVICES			BENEFIT FOR:	TEEB icon
Regulating	Flood impact reduction		Settlements downstream	
	Retaining water for a long time so that it is available for use by the communities (water storage)		Population around the wetland; National Water and Sewerage Corporation (NWSC) who extracts water from the Nabajjuzi for public water supply in the Masaka area.	
	Groundwater recharge and discharge		Vegetation and population in the surroundings of the wetland	
	Erosion and sedimentation control (mainly Nabajjuzi)		Farmers, vegetation in the wetland, downstream users	
	Influence/amelioration of microclimate (by papyrus first of all) (publication??)		Human population, agriculture and animals in the catchment	
	Nutrient reduction and water purification by de-nitrification, mineralization, primary production, burial and harvesting (papyrus, rice, yam)		Water quality in the wetland and in downstream water bodies (e.g. River Katonga)	
Provisioning	Drinking water piped by NWSC (only Nabajjuzi)		Population in the Masaka Water Supply Area	
	Drinking water extracted by riparian communities		Riparian communities	
	Food production	Food supply from animals: fish (Mud- and Lung fish), game (Sitatunga, wild pigs) (mainly Nabajjuzi)	Population around the wetland	
		Food supply from natural plants (wild fruits)	Population around the wetland	
		Land for farming: • limited farming in Nabajjuzi in the form of 'wetland edge cultivation': banana, maize, cassava, sugar cane, yams and pineapple • large scale farming in Namatala: mainly rice but also sugar cane, yam	Population around the wetland	
		Land for grazing (on the seasonal parts and on the drained parts of the wetland)	Population around the wetland	

SERVICES			BENEFIT FOR:	TEEB icon
	Natural wild products	Biomass energy: fire wood	Population around the wetland	
		Timber	Population around the wetland	
		Grass for mulching farmlands	Population around the wetland	
		Building materials: papyrus, reeds, poles from palm trees, grass for thatching	Population around the wetland	
		Building materials: bricks, clay, sand	Population around the wetland	
		Craft materials: papyrus, palm trees, sedges	Population around the wetland	
		Source of traditional medicinal plants	Population around the wetland	
	Transport routes for goods and people (canoes)		Population around the wetland	
Cultural	Presence of traditional craft and house-building techniques		Population around the wetland	
	Place for sacred worship (only Nabajjuzi)		Population around the wetland	
	Eco-tourism: bird- and animal watching from a watchtower (only Nabajjuzi)		External visitors, income for local population	
	Largely natural landscape character: aesthetic value (only Nabajjuzi)		External visitors, population in and around the wetland	

Sources: MWLE, 2004; information from L. Iyango and R. Kaggwa; presentation of S. Namaalwa in the Mali project meeting; NatureUganda, 2008

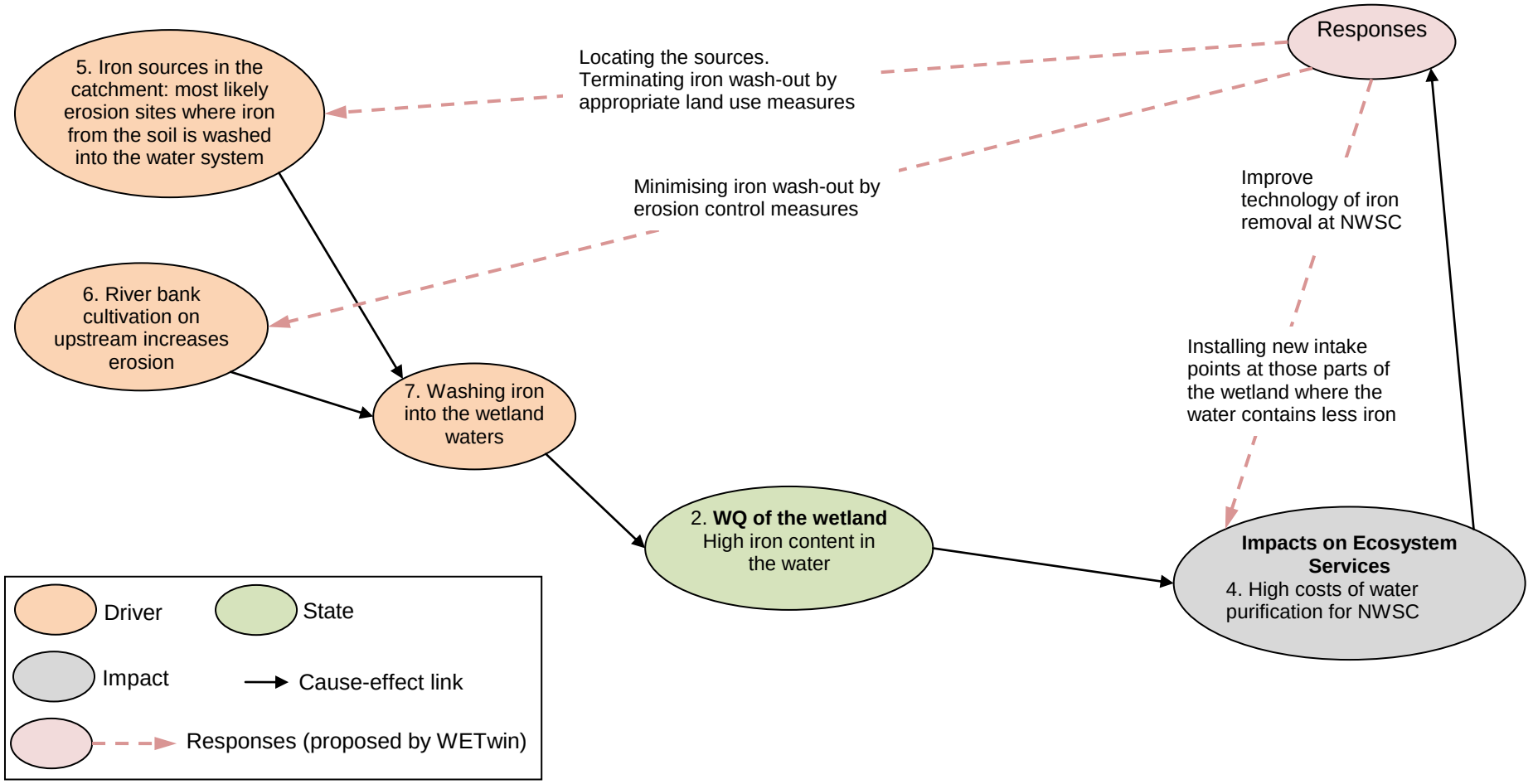
4.2.4 Problems related to the Nabajjuzi wetland

Problem I.: Potential consequences of limited water resources of Nabajjuzi (a likely problem in the future):



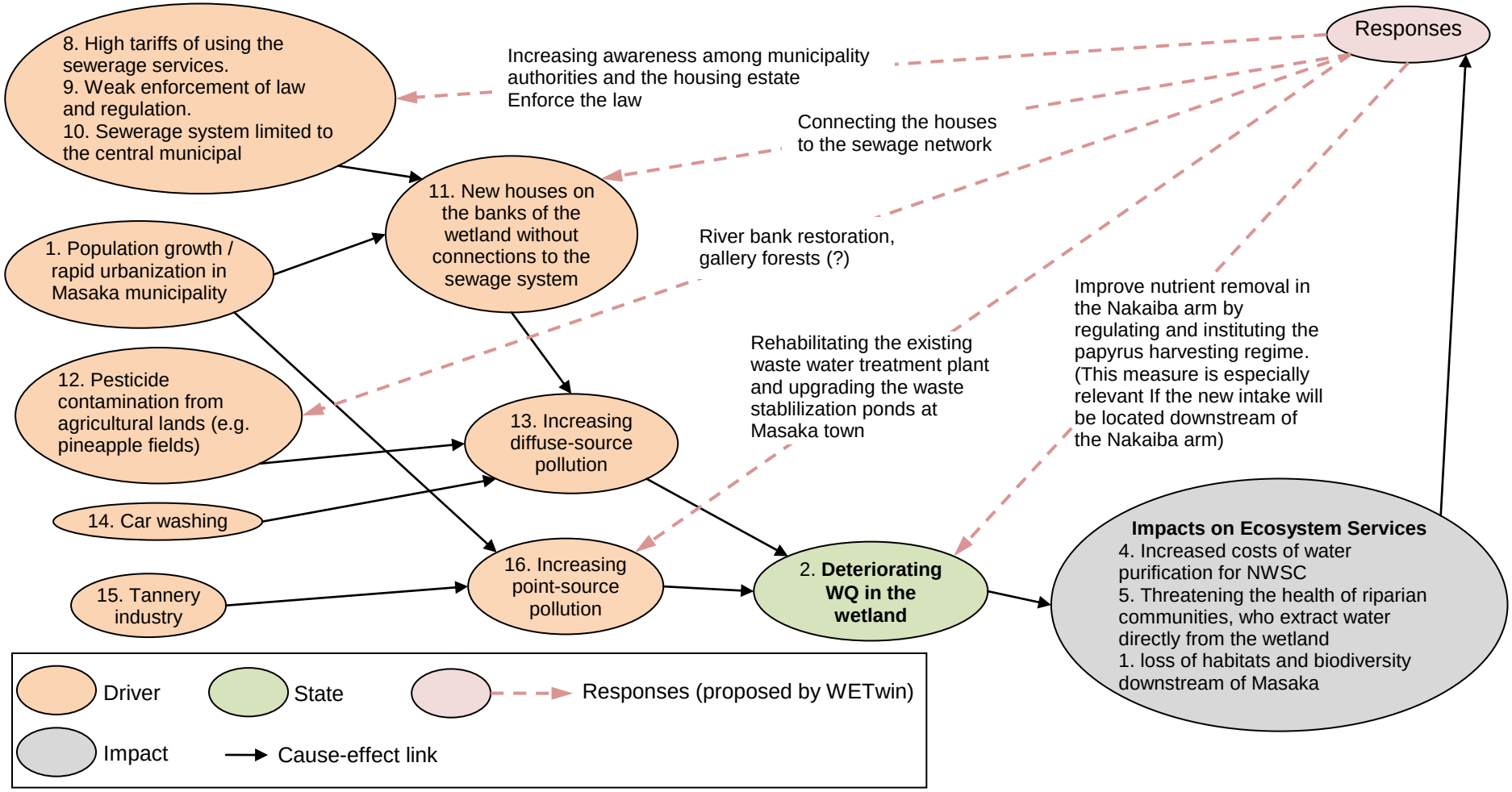
Sources: MWLE, 2004; information from L. Iyango and R. Kaggwa; presentation of S. Namaalwa in the Mali project meeting; Conclusions of the discussion on responses at the S-African and Austrian project meetings of WETwin (Loskopdam, April 2010; Lunz, November 2011; R. Kaggwa, S. Namaalwa, A. van Dam and T. Hein)

Problem II.: Iron contamination in Nabajjuzi:



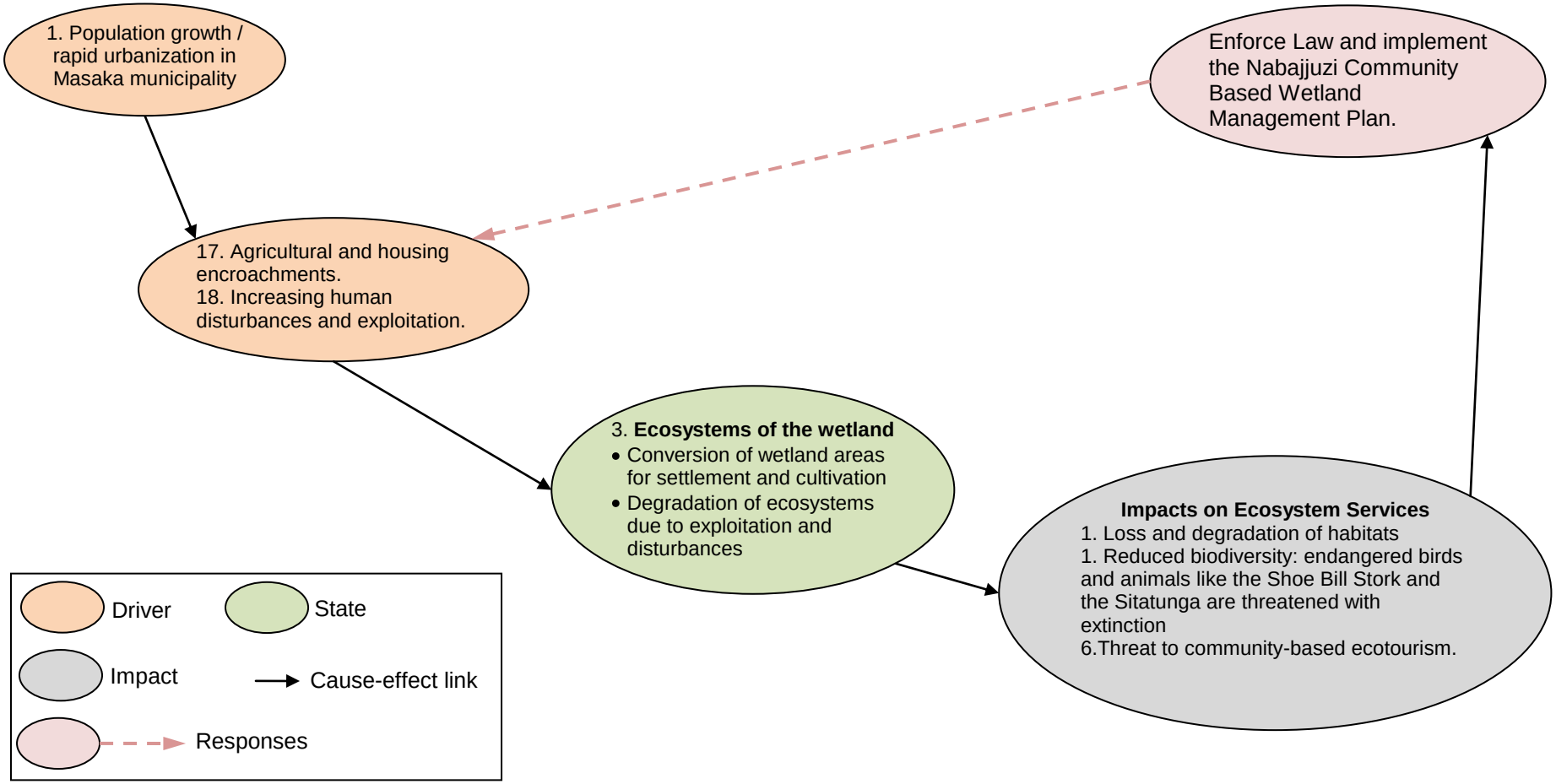
Sources: MWLE, 2004; information from L. Iyango and R. Kaggwa; presentation of S. Namaalwa in the Mali project meeting; presentation of P. Winkler in the Delft project meeting

Problem III.: Nutrient and chemical pollution in Nabajjuzi:



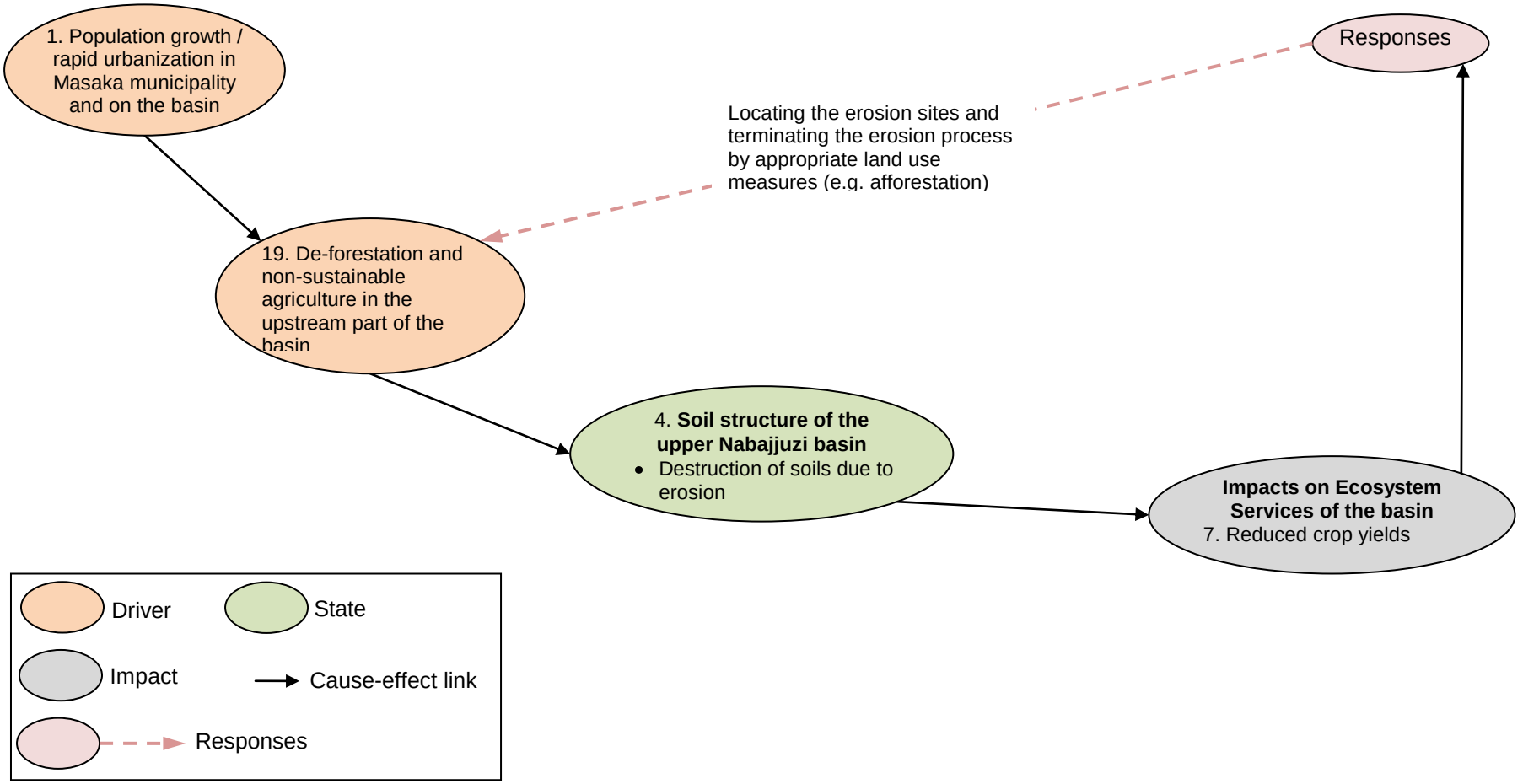
Sources: MWLE, 2004; information from L. Iyango and R. Kaggwa; presentation of S. Namaalwa in the Mali project meeting; presentation of P. Winkler in the Delft project meeting; NatureUganda, 2008; Conclusions of the discussion on responses at the S-African and Austrian project meeting of WETwin (Loskopdam, April 2010; Lunz, November 2010; R. Kaggwa, S. Namaalwa, A. van Dam and T. Hein)

Problem IV.: Encroachment, exploitation and disturbance:



Sources: Byaruhanga & Kigoolo, 2005; NatureUganda, 2008; The Monitor, 2009; MWLE, 2004

Problem V.: Non-sustainable agriculture on the upstream basin of Nabajjuzi



Sources: Presentation of Bernhard Freyer on sustainable agriculture in Uganda (WETwin project meeting Lunz, Austria)

Detailed description of the DSI components at Nabajjuzi:

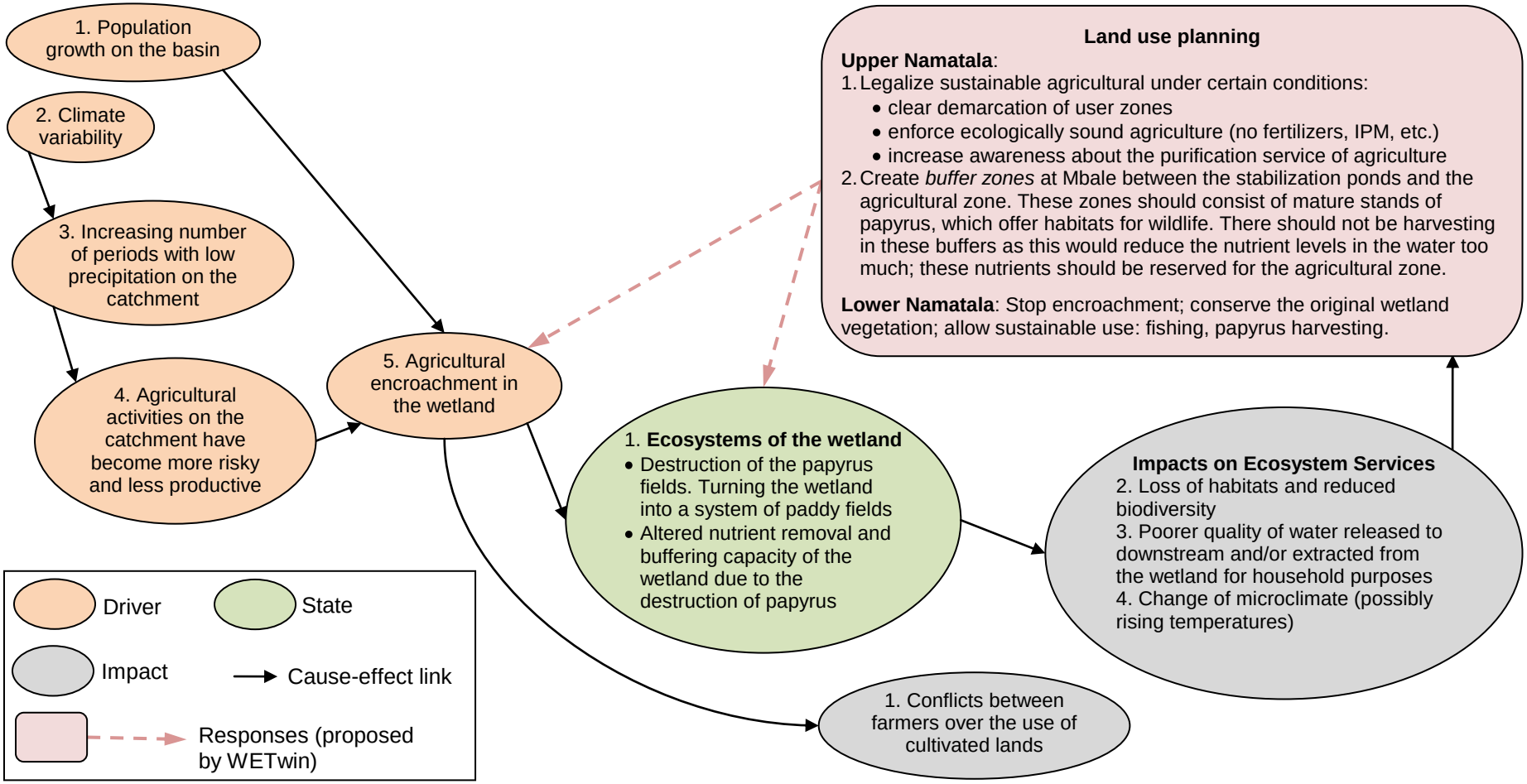
DSI component		Spatial scales	Description	
			Present (+ Past)	Future
Drivers	Population growth	Whole country	Uganda: from 5 million people to 26 million in the past 50 years. Leads to increased demand of water and food and to increased pollution	Population is likely to increase. Annual population growth rate (1991–2002): 3.4%
	Urbanisation	Masaka municipality + other riparian settlements	Development of new settlements due to population growth and to richness in resources	Settlements are likely to grow
	Agriculture	Catchment	Development of new agricultural areas due to the increased need of food	Is likely to increase
	Industrialisation	Catchment	Parallel to increasing population	Is likely to increase
	Iron sources	Catchment	The iron sources are natural	Will persist
	Tannery industry	Wetland near the tannery effluent at Masaka	Effluents from the tannery are discharged directly into the wetland and this is a big pollutant that is likely to cause biodiversity loss, changes in water quality and threats to public health, generally compromising the ecosystem health and impairing the ecological functioning of the wetland. The effluent is no more than 400m from the water extraction and treatment plant of Masaka.	no data
	Increasing water intake by NWSC	Intake point in the wetland at Masaka	Increased demand of water due to growing population	Is likely to increase
	Washing iron into the water	Wetland upstream of Masaka	It has to be investigated if iron is washed into the water by river bank erosion or due to agriculture	To be investigated
	Point source pollution (nutrients and chemical pollutants)	Wetland	Industrial site: leather tannery; car washing activities; municipal effluents, discharge of municipal wastewater	Additional industrial sites possible, municipal wastewater will increase with growing population
	Diffuse source pollution (nutrients and chemical pollutants)	Catchment	Agriculture (fertilisers, pesticides), waste disposal, wastewater from scattered houses	Will increase with growing population

	DSI component	Spatial scales	Description	
			Present (+ Past)	Future
	• Agricultural and housing encroachments. • Increasing human disturbances and exploitation.	Wetland	Agricultural encroachment due to expanding 'wetland edge cultivation'. Encroachers have taken over at least 500 hectares of wetlands in Masaka District, destroying the fragile eco-system in the area. The most affected wetlands include Nabajjuzi. Nabajjuzi is also threatened by the rapidly growing commercialisation of wetland resources. The demand for crafts materials in the nearby centres has considerably increased. This has in turn increased the levels of extraction of raw materials from the wetland. Hunting of the Sitatunga for meat especially by the military personnel is of particular concern.	Encroachment, disturbances and exploitation will likely increase in the future by the increasing population, unless proper conservation measures are taken.
Changes of state	Shortage of water	Wetland & settlements around	Due to increasing population and dry periods	Is expected to increase
	High iron content in the water	Intake point in the wetland at Masaka	Removal of iron from the drinking water is costly.	Will persist
	Nutrient loads in the water	Wetland	Security of drinking water is endangered by nutrient input	Is likely to increase
	Pollutants in the water	Wetland and around	The presence of pollutants in the water has to be investigated. Potential impact on humans and animals can be high	To be investigated
Impacts	Damages to wetland vegetation and ecology	Wetland	Water shortage, increasing water intake, high nutrient and pollutant loads harm the ecology of the wetland	Is likely to increase
	Ecosystem services downstream are endangered	Wetland and around	Quality of human livelihood is endangered due to water shortage and (potential) pollutant loads	Is likely to increase
	Shortage of drinking water	Masaka municipality	For the time being the water demand of Masaka is satisfied by intakes from the wetlands	It is likely that the demand for drinking water will not be met with growing population
	High costs for iron removal	Masaka municipality	The high iron loads in the water make it necessary to remove iron	Will persist
	Low drinking water quality	Wetland and around	Nutrient loads make it necessary to treat the drinking water	Will persist

Sources: MWLE, 2004; Wong et al., 2005b; information from L. Iyango and R. Kaggwa; Byaruhanga & Kigoolo, 2005; NatureUganda, 2008; The Monitor, 2009

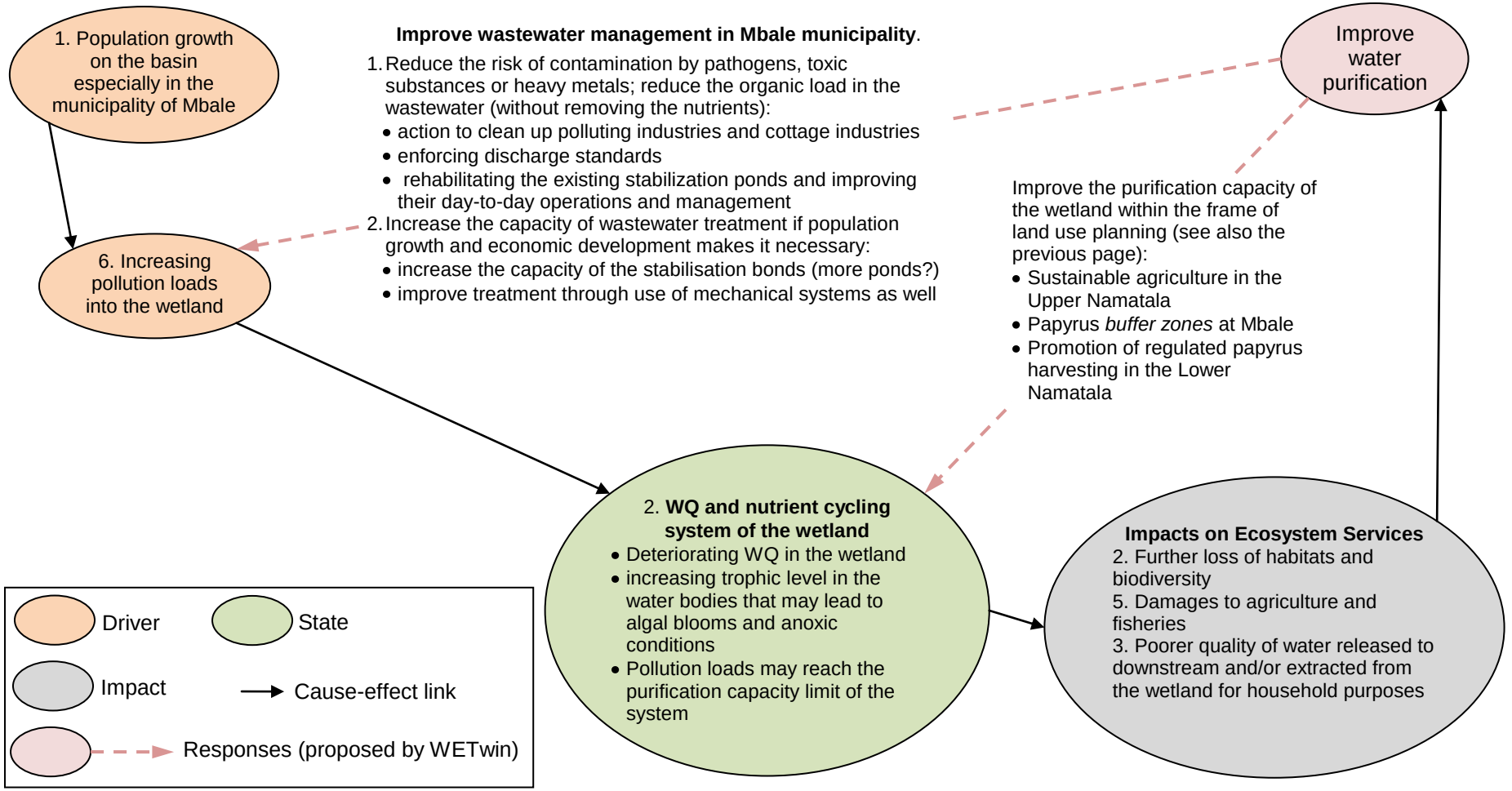
4.2.5 Problems related to the Namatala wetland

Problem I.: Agricultural encroachment in Namatala:



Sources: Information from L. Iyango and R. Kaggwa; presentation of S. Namaalwa in the Mali project meeting; Edyegu, 2010; Conclusions of the discussion on responses at the S-African project meeting of WETwin (Loskopdam, April 2010; R. Kaggwa, S. Namaalwa, A. van Dam and T. Hein)

Problem II.: Increasing urban and industrial pollution loads into Namatala:



Sources: Information from L. Iyango and R. Kaggwa; presentation of S. Namaalwa in the Mali project meeting; Conclusions of the discussion on responses at the S-African project meeting of WETwin (Loskopdam, April 2010; R. Kaggwa, S. Namaalwa, A. van Dam and T. Hein)

Detailed description of DSI components at Namatala:

DSI component		Spatial scales	Description	
			Present (+ Past)	Future
Drivers	Population growth	Whole country	Uganda: from 5 million people to 26 million in the past 50 years. Leads to increased demand of water and food and to increased pollution	Population is likely to increase. Annual population growth rate (1991–2002): 3.4%
	Urbanisation	Catchment	Growth of the town of Mbale	Is likely to grow
	Agriculture	Catchment and wetland	Development of new agricultural areas due to the increased need of food	Is likely to increase
	Agricultural encroachment into the wetland	Wetland	Large parts of the wetland are already converted to agricultural land (especially rice fields).	Will continue
	Increasing nutrient loads	Wetland	Nutrient inputs: (1) wastewater from the city of Mbale (2) domestic effluents from scattered houses and streets (3) fertiliser use on agricultural fields (extent of fertiliser use: to be investigated)	Will increase with increasing population if no measures are taken
	Pollutant inputs	Wetland	From the wastewater of the city of Mbale. Possible pesticide use in agriculture Questions: which pollutants? Are pesticides used?	?
Changes of state	Destruction of the papyrus cover	Wetland	Due to conversion of the wetland area into agricultural areas. Destruction of the natural papyrus vegetation is already advanced	Is expected to increase
	Altered nutrient dynamics and buffering capacity	Wetland	The effect of the destruction of the papyrus cover on the nutrient buffering capacity of the wetland has to be investigated	?
	Increased trophic level in the water bodies	Wetland	Increased amounts of nutrients (i.e. increased trophic level) may lead to deteriorating water quality, algal blooms and the loss of species	?
	Pollutants in the water	Wetland	The presence of pollutants in the water has to be investigated. Potential impact on humans and animals can be high	To be investigated

DSI component		Spatial scales	Description	
			Present (+ Past)	Future
Impacts	Loss of habitats	Wetland	Destruction of the papyrus cover leads to the loss of characteristic habitats for typical species (e.g. birds)	Is likely to increase
	Loss of biodiversity	Wetland and around	Due to the loss of habitats the biodiversity will decrease	Is likely to increase
	Poorer water quality	Wetland and around	Increased nutrient input, lowered nutrient buffering capacity and the possible input of pollutants leads to poor water quality	Is likely to become problematic
	Change of microclimate (possibly rising temperatures)	Catchment	The depletion of the papyrus cover influences the microclimate of the region. Lowered evapotranspiration may lead to higher temperatures. (To be investigated)	?
	Damages to agriculture and fisheries	Catchment	High nutrient loads and pollutants endanger the quality of the harvested food and fish	?
	Conflicts between farmers over the use of cultivated lands	Wetland	There is a raging border dispute between the Bagwere and Bagisu farmers, with each claiming the other was cultivating beyond their district boundary. Unfortunately, the conflict has resulted in fatalities as well.	A speedy demarcation of the disputed boundary between Budaka and Mbale districts is now taking place (July 2010) in order to eliminate such conflicts in the future.

Sources: Wong et al., 2005b; information from L. Iyango and R. Kaggwa; Edyegu, 2010

4.2.6 Identification of tradeoffs between ecosystem services

Nabajjuzzi:

Resource harvesting	↔	Hydrological and ecological functioning

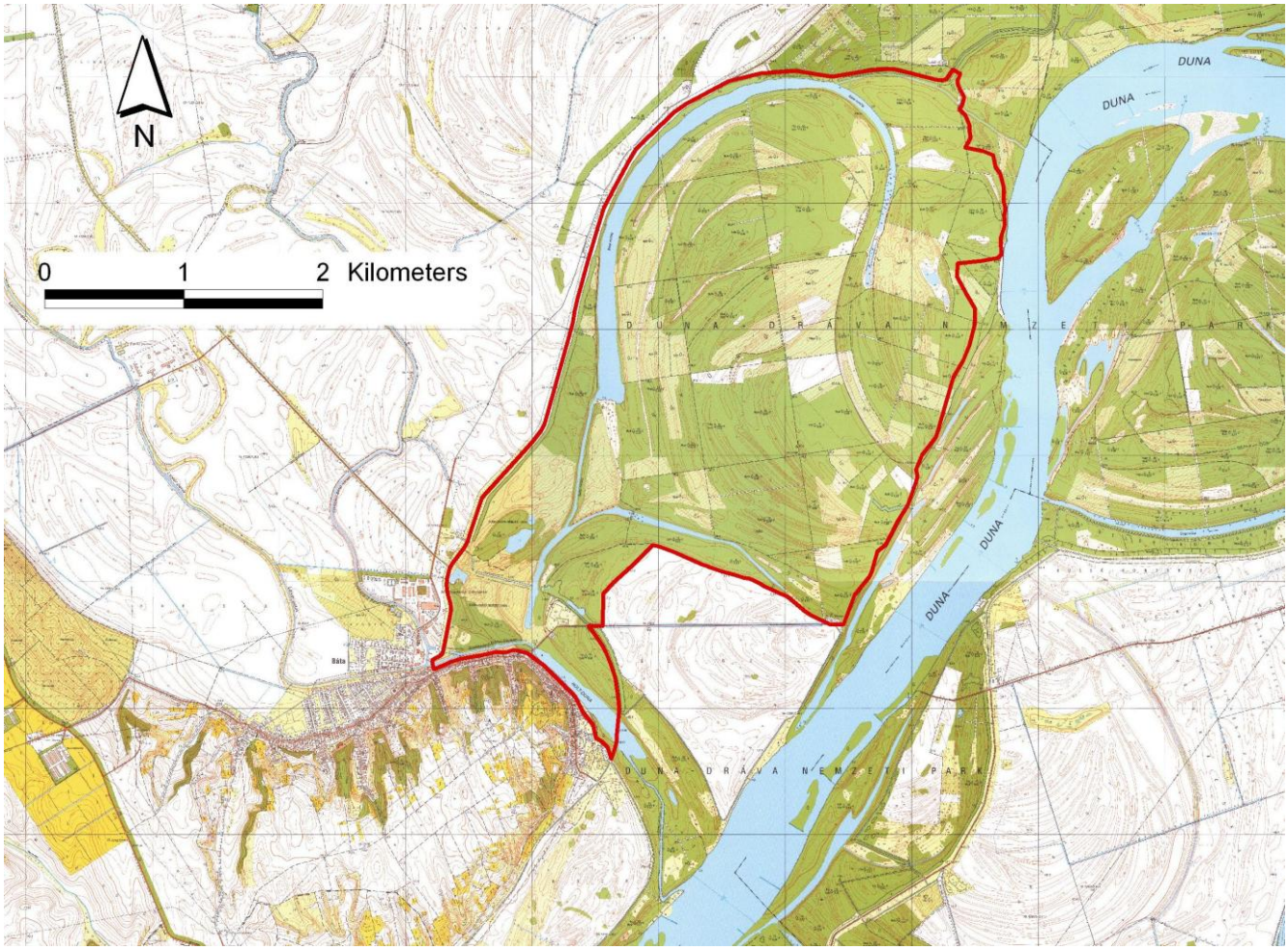
Namatala:

Food production	↔	Water purification
Crop production	↔	Biodiversity conservation

Source: presentation of S. Namaalwa in the Mali project meeting

4.3 Gemenc floodplain: Báta sub-system

4.3.1 Delineation of the Báta sub-system



4.3.2 Ecosystem Services of the Gemenc floodplain

4.3.2.1 Habitat Services

HABITATS	BIOTIC COMMUNITIES	TEEB icon	WINTER	SUMMER
Floodplain forests: nesting and feeding habitat for key predatory birds	Rare and valuable birds nesting in the floodplain or in the surrounding areas, e.g. White.tailed Eagle		X	X
Floodplain forests and water bodies: nesting, feeding and resting habitat for key migratory birds	Rare and valuable migratory birds nesting in the Gemenc, e.g. Black Stork. Migratory birds from other European nesting places using the Gemenc as resting and feeding place during migration.			X
Wintering habitat for migratory bird species	Guest birds from the North		X	
Floodplain water bodies: spawning, nursery and feeding habitats for fish	Fish stock of the Danube: carp, pike, catfish and bream			X
Floodplain water bodies: resting habitats for fish	Fish stock of the Danube		X	
Floodplain forests and water bodies: Habitat for unique mammals	wild cat, beaver		X	X
Habitats for characteristic alluvial flora			X	X
Gemenc as core (generator) area within the Danubian ecological network	Aquatic and alluvial communities along the River Danube		X	X

Sources: Kalocsa & Tamás, 2004; Tamás & Kalocsa, 2004; Tamás & Kempl, 2008; Zsuffa, 2001

4.3.2.2 Regulating, Provisioning and Cultural Services

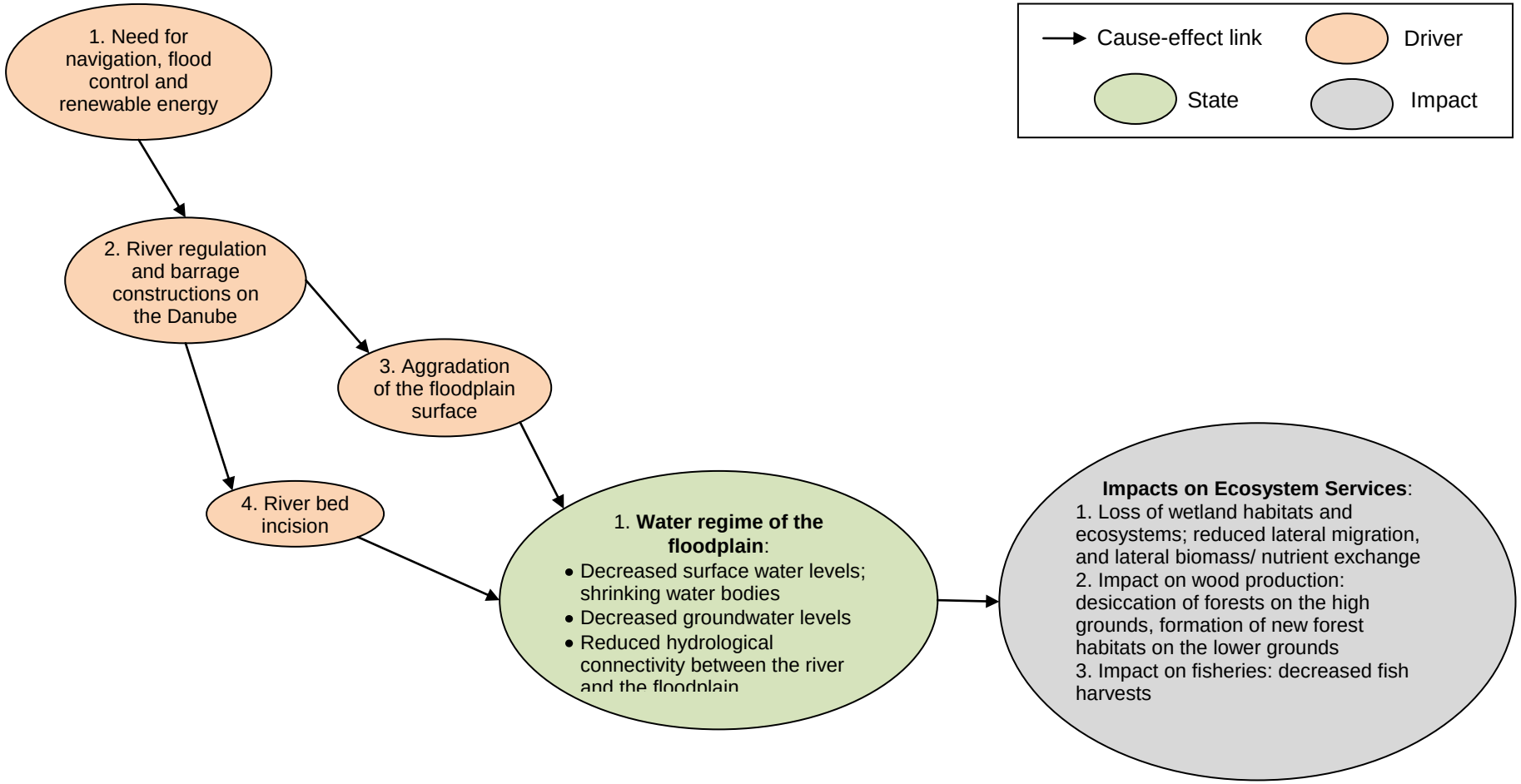
SERVICES				BENEFIT FOR:	TEEB icon	BENEFITS DURING	
						WINTER	SUMMER
Regulating	Contribution to the mitigation of flood peaks of the Danube (limited)			Settlements, cultivated lands along the Danube downstream of Gemenc		X	X
	Water purification	Nutrient retention via sedimentation and burial in the water bodies of Gemenc (rather limited)		Downstream reaches of the Danube + Black Sea		X	X
		Nutrient removal via denitrification and biomass removal (wood production) (rather limited)		Downstream reaches of the Danube + Black Sea		X	X
	Control of mosquitoes.			People living in the neighbouring settlements, visitors, large mammals living in the floodplain (deers, roe-deers, wild boars). Mosquitoes of the Gemenc don't spread diseases. Nevertheless they could turn conditions to unbearable for humans and animals.			X
Provisioning	Food production	Game meat as a result of hunting		Income for the Gemenc Forestry Company after selling the meat on the food market		X	
		Mushrooms collected by private persons		Local consumption			X
		Fisheries	Functions of nursery / spawning zone / species reproduction	Fisheries along the river Danube			X
			Extensive commercial fisheries	Local consumption; income for the fisheries cooperatives		X	
			Illegal fisheries	Local consumption		X	X
			Angling practiced by private persons	Local consumption			X
	Natural products	Intensive commercial wood production		Income for the Gemenc Forestry Company after selling timber products on the market		X	
		Extensive reed harvesting		Local usage		X	
	Receiving external drainage waters and transmitting them to the main river channel			Agricultural, urban and natural lands outside the floodplain		X	X

SERVICES		BENEFIT FOR:	TEEB icon	BENEFITS DURING	
				WINTER	SUMMER
Cultural	Recreational angling, canoeing and hiking	Local communities + external visitors			X
	Hunting for guest hunters	National and international guest hunters; Income for the Gemenc Forestry Company			X
	Supporting national/international tourism	Incomes for hotels and restaurants in the neighbouring settlements; Domestic and international tourists.		X	
	Eco-tourism: organized excursions guided by the experts of the National Park	Local and external visitors; income for the Danube-Drava National Park			X

Sources: Kalocsa & Tamás, 2004; Tamás & Kalocsa, 2004; Tamás & Kempl, 2008; Zsuffa, 2001

4.3.3 Problem I.: Desiccation of the floodplain

The Impact of river regulation on the ecosystem services of the Gemenc:



Sources: Kalocsa & Tamás, 2004; Tamás & Kalocsa, 2004; Tamás & Kempl, 2008; Zsuffa, 2001

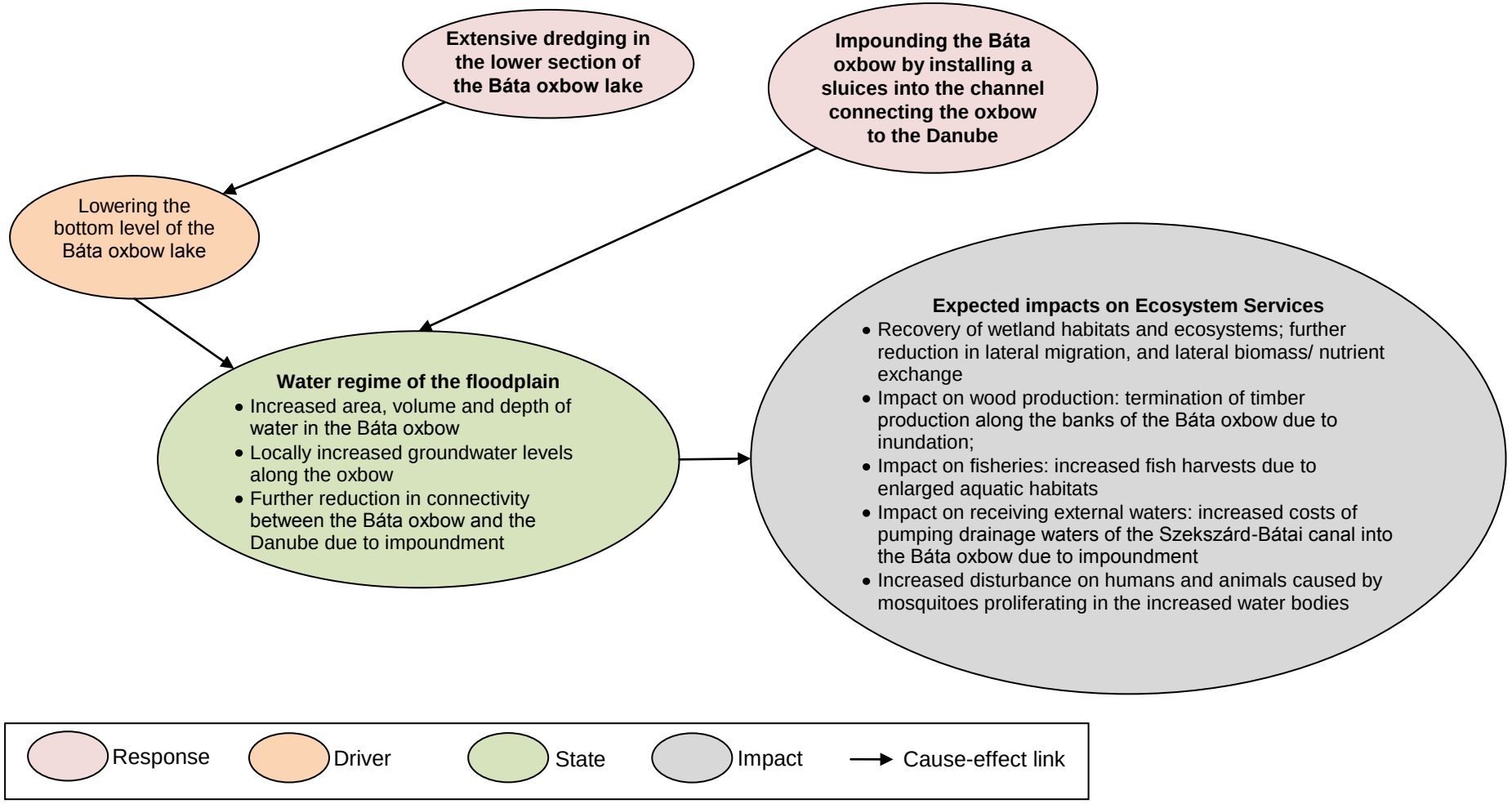
Detailed description of the DSI components:

DSI components		Spatial scales	Description	
			Present (+ past)	**Future**
Drivers	Need for navigation, flood control and renewable energy	Countries along the Rhine-Main-Danube waterway	The need for navigation, the volumes of transported freight as well as the need for flood safety and renewable energy keep on growing	It is expected that freight transportation on the Danube will increase up to the level of the Rhine. Demand for renewable energy will be increasing further.
	River regulation and barrage constructions on the Danube	Reach of the Danube from the Black Forest (Germany) to the Hungarian-Serbian border	Meanders of the river have been cut short and the side arms have been closed. The main channel of the Danube has been stabilised with the help of stone structures. Several barrages were built on the German, Austrian and Slovakian reach of the river.	Navigation conditions along the Hungarian reach of the Danube is planned to be improved by dredging, constructing new groins and elongating the existing ones in the main channel. It is also expected that few more barrages will be constructed in the upstream Danube.
	River bed incision	Reach of the river Danube adjacent to the Gemenc floodplain.	River training has shortened and narrowed the river channel resulting in significant increase of water velocities. Due to the barrages (that withhold the sediment in their reservoirs) the sediment transport deficit of the downstream reaches has increased. These all finally led to the degradation of the riverbed.	Incision will continue in the future as well and will even be enhanced if the planned river training measures will be implemented.
	Aggradation of the floodplain surface	The Gemenc floodplain	Each flood of the Danube deposits fine suspended sediment on the surface of the floodplain. In addition the beds of the water bodies are exposed to continuous biological sedimentation. River meandering had time-to-time undone these processes before the regulation of the river. However this dynamic equilibrium has been terminated by the stabilisation of the main channel, thus removing the obstacles from the way of aggradation. As a result 3-6 m layer of clay and silt have already been deposited on the surface and 6-10 m in the beds of the floodplain during the last 200 years.	Aggradation of the surface and the beds of the floodplain will continue in the future as well.

DSI components		Spatial scales	Description	
			Present (+ past)	**Future**
Change of State	Decreased surface water levels; shrinking water bodies; Decreased groundwater levels; Reduced hydrological connectivity between the river and the floodplain	The Gemenc floodplain and the adjacent Danube reach	Because of incision, the annual minimum, mean and maximum water levels of the Danube at the Gemenc have decreased with 1.30, 1.60 and 0.80 meters during the XX. Century. The area and the depth of the floodplain water bodies have been decreased to their fifth or even more.	The desiccation process will proceed in the future as well. Within 50-100 years the water bodies of the Gemenc floodplain will completely disappear.
Impacts	Impact on Ecosystem Health	The Gemenc floodplain and the adjacent Danube reach	The fish stock and the sizes of other aquatic, semi-aquatic communities have been decreased considerable, due to the destruction of aquatic habitats. The reduced hydrological connectivity has worsened the lateral migration conditions, which has resulted in decreased access for river fish to spawning and feeding grounds. Land-water ecotones have also decreased a lot resulting in the destruction of communities living in these important wetland habitats.	Further destruction of wetland habitats is expected due to the continuing desiccation process.
	Impact on wood production	The Gemenc floodplain	It seems that forestry has benefited from the desiccation process since the extent of forests has increased on the expense of wetland and water areas. On the other hand desiccation of forests has been observed on the higher grounds resulting in losses in wood.	The ongoing desiccation process will extend further the forest habitats toward the lower grounds of the floodplain. On the other hand the desiccation on the high grounds will proceed as well.
	Impact on fisheries	The Gemenc floodplain and the adjacent Danube reach	Thanks to the very rich fish stock of the Danube and its floodplains, fisheries were the primary land use activities on the Gemenc before the river training works. Today the role of fisheries and the amounts of fish catches are only small fractions of the ones before the training works.	It is expected that fish catches will decrease further due to the further destruction and deterioration of habitat and migration conditions.

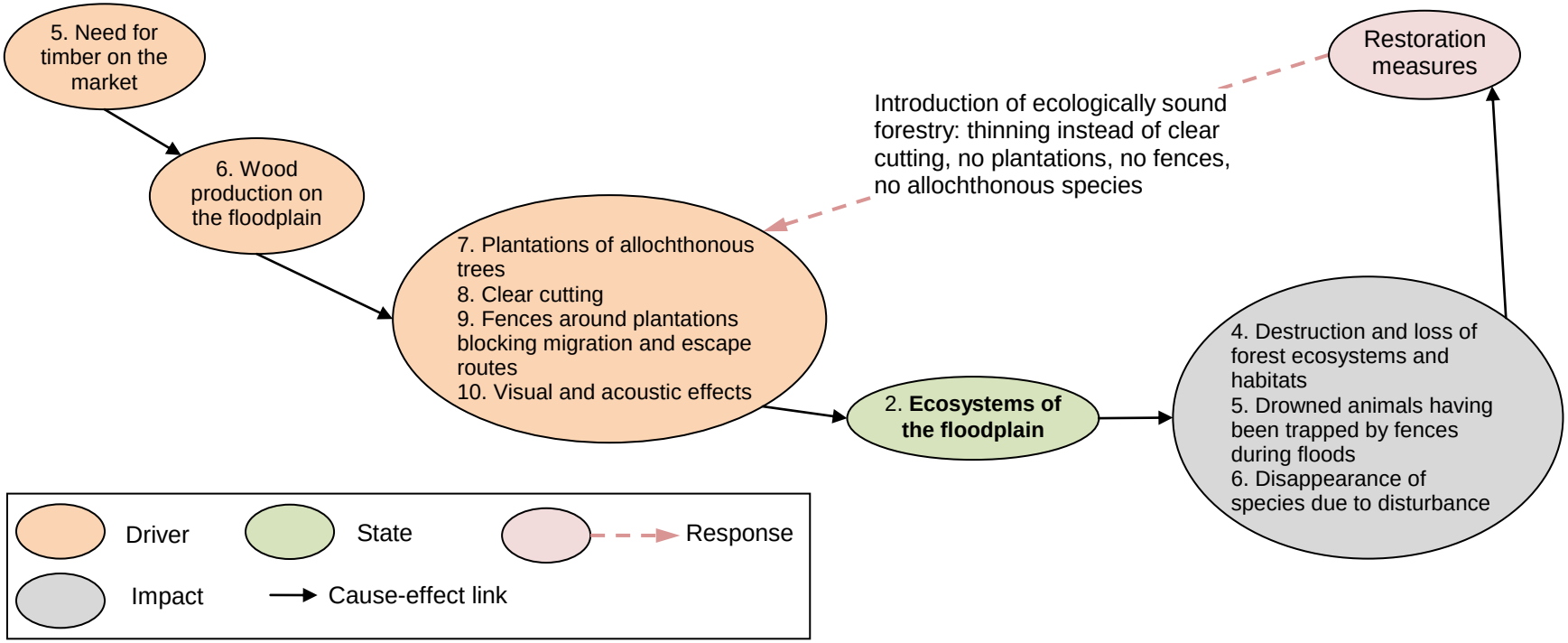
Sources: AQUIFER, 2008; Kalocsa & Tamás, 2004; Tamás & Kalocsa, 2004; Tamás & Kempl, 2008; VITUKI, 2007; Zsuffa, 2001

Responses envisaged by the World Bank GEF project for the Báta sub-system, and the expected impacts of these responses:



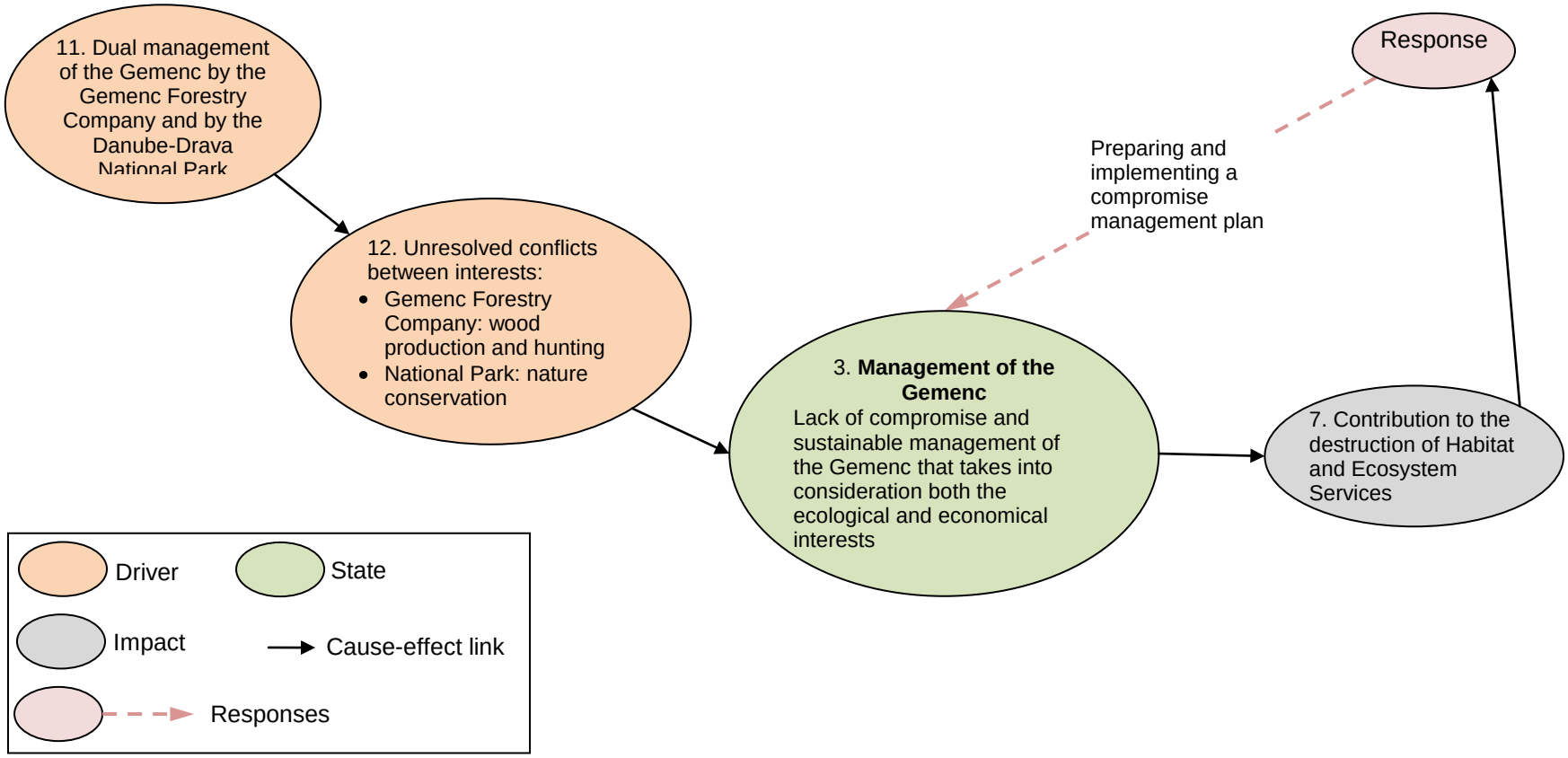
Sources: Virág et al., 2009; VITUKI & VTK Innosystem, 2005

4.3.4 Problem II.: Degradation of alluvial forests in the Gemenc floodplain due to forestry activities



Sources: Zsuffa, 2001; VITUKI & VTK Innosystem 2005

4.3.5 Problem III.: Management problems in the Gemenc floodplain



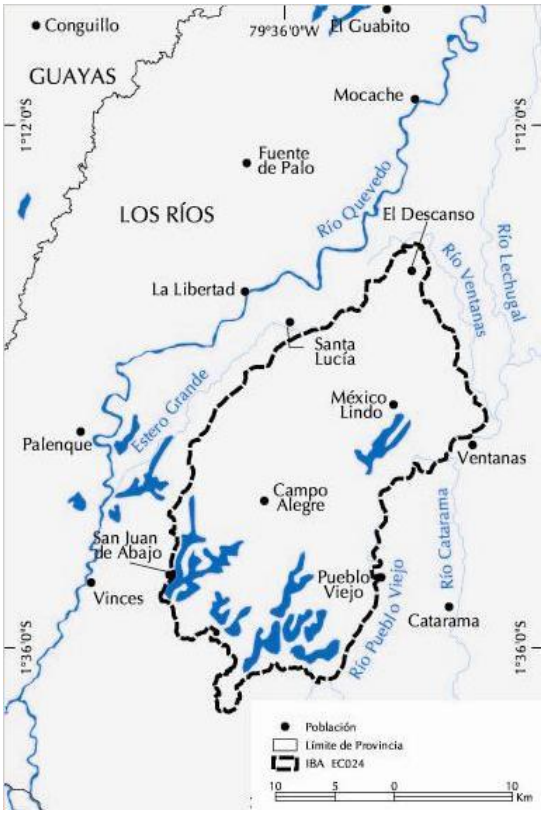
Sources: Pataki, 2009; VITUKI & VTK Innosystem 2005

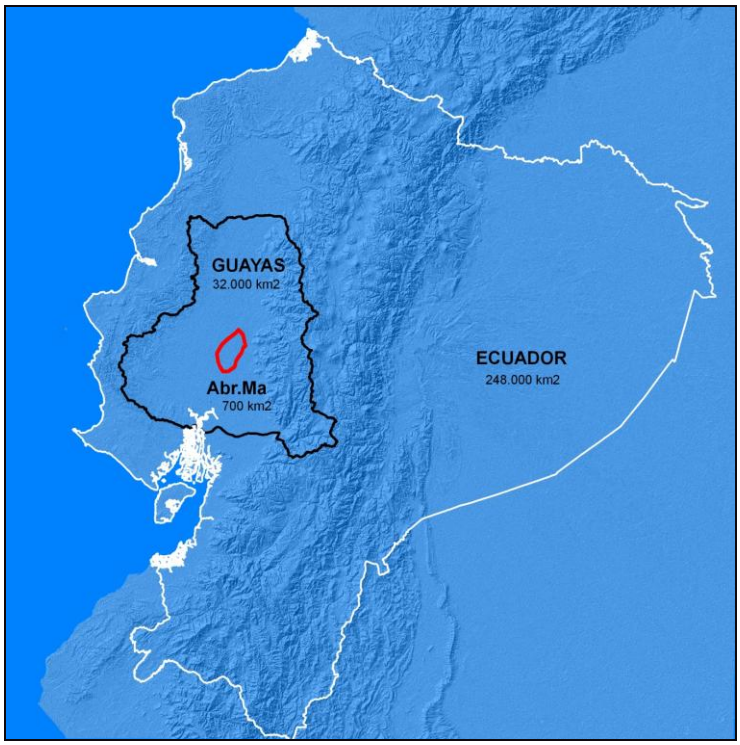
4.3.6 Identification of tradeoffs between ecosystem services

Navigation and flood control (→ river training)	↔	Ecosystem health and biodiversity
Navigation and flood control (→ river training)	↔	Fisheries
Wood production	↔	Ecosystem health and biodiversity
Wood production	↔	Fisheries

4.4 Abras de Mantequilla wetland

4.4.1 Delineation of the RAMSAR wetland Abras de Mantequilla (Mantequilla, Mapancillo, Cimaron, El Garzal) and of the Guayas river basin





4.4.2 Ecosystem Services of the Abras de Mantequilla wetland

4.4.2.1 Habitat Services

HABITATS	BIOTIC COMMUNITIES	TEEB icon	DESCRIPTION	
			present	future
Habitats for birds	Resident and migratory birds	 	There is a total of 81 different bird species (Man-Ging 1999). Nonetheless, during the course of the project "Capacitacion Comunitaria/Local para el Desarrollo Ecoturistico de los parches de Bosques en Abras de Mantequilla", another 59 bird species were observed. From this pool, 13 were considered new species, Considering other initiatives a total of 100 species categorized in 40 families. From this total 15% correspond to endemic tumbesine region, 9% are presumed boreal migratory bird, 3% are considered austral migratory birds. From the species registered in the RAMSAR 2008 sheet, according to Ridgeli and Greenfield (2001) categorization, just 3 are considered rare, 22 uncommon, 25 common.	If the current trend continues, local biodiversity could be expected to suffer considerable loss unless proper measures are taken to alter these patterns
Habitats for fish	Resident fish stock of the AdM. Fish stock of rivers of the Los Ríos province using the AdM as spawning and nursery habitat		The RAMSAR 2008 sheet indicated that the water quality indexes for most of them reported 100% for NO3 and NH4. For PO4 the readings oscillated between 75% and 80%. For dissolved O2 the readings reported values above 80%. In all, the wetland system reports an acceptable water quality state for maintaining local bio-diversity. As matter of fact, these indexes reported an improvement from readings taken in June of 1981, which suggested an overall improvement in the site's condition. The ictioplantonic composition of river Vinces is constituted by larva and young fish, with a density of 160 larvas/m^2 and 1194 young fish per m^2 just in Palenque and Vinces communities all (which represent around 12% and 88% of total biomass). Stationally, during the wet season the egg, "pre-larva" and larva presence in the zone is notisable. On the other hand, "pre-larva" and larva are practically non-existent during dry season, but fish eggs decrease dramatically. In Pallenque river, measurements shows 80 fish larva per m2 with similar morphological characteristics shown by the Vinces river. A considerable adult fish supply is observed intriver lanes around the communities settled in the wetland. They belong to the Lebiasinidae family. The local stakeholders call this the Huaija or Anchoa, a species which length revolves around 7 and 8 cm. W. Rebello et. al. (2004) analyzed a total of 304 specimens from 9 different families (Curimatorbis Boulengeri or dica 26.3%, Brycondentex or dama 23.7%, Leporinus Ecuadoriensis 12.5%, Ramdia Cinerascense or barbudo 12.8%)	If the current trend continues, local biodiversity could be expected to suffer considerable loss unless proper measures are taken to alter these patterns

Source: presentation of M. Arias in the Mali project meeting (+ see references in the text)

4.4.2.2 Regulating, Provisioning and Cultural Services

SERVICES			BENEFIT FOR:	TEEB icon	DESCRIPTION		BENEFITS DURING	
					present	future	wet season	dry season
Regulating	Flood regulation		Lands and settlements downstream: Vinces, Santa Lucia, Palestina, …		The importance of this wetland system flood regulation capacity was acknowledged by the RAMSAR convention. During raining season the wetland conglomerate known as “Abras de Mantequilla” is capable of storing up to 56000 m3 of tributary water inflow from rivers “Vinces”, “Quevedo” and “Pueblo Viejo”. This has a direct incidence in maintaining local climate balance.	According to projection and planning by CEDEGE, the hydrological system will be dramatically altered by massive dam construction projects upstream in the tributary and affluent rivers. This could severely hamper the flood regulation capacity and potential of the wetland. This role would then be assumed by the dam system to be constructed in the tributary basin.	X	
	Erosion control and water purification	Sediment retention	Downstream waters, and surrounding locations		This wetland system periodically receives important discharges of clay and limo material from upstream rivers. The variation of the readings for pH levels ranged from 6.8 to7.3. This suggests a slight acidity in the sediment content, which could be result of oxidation of accumulated organic matter. Nonetheless, the RAMSAR 2008 sheet indicated that the water quality indexes reported a 100% for NO3 and NH4. For PO4 the readings oscillated between 75% and 80%. For dissolved O2 the readings reported values above 80%. In all, the wetland system reports an acceptable water quality state for maintaining local bio-diversity. As matter of fact, these indexes reported an improvement from readings taken in June of 1981, which suggested an overall improvement in the site’s condition. During workshops, local stakeholder perception was fixed on the notion that the wetland does not provide this service. At the very least, they did not consider it relevant to their everyday life.	(no data)	X	
		Self purification	Downstream waters, and surrounding locations				X	X

SERVICES			BENEFIT FOR:	TEEB icon	DESCRIPTION		BENEFITS DURING	
					present	future	wet season	dry season
Provisioning	Drinking water	Secure water storage	Local consumption (domestic, commercial uses, industrial uses)		The RAMSAR 2008 sheet indicated that the water quality indexes reported a 100% for NO3 and NH4. For PO4 the readings oscillated between 75% and 80%. For dissolved O2 the readings reported values above 80%. In all, the wetland system reports an acceptable water quality state for maintaining local bio-diversity. As matter of fact, these indexes reported an improvement from readings taken in June of 1981, which suggested an overall improvement in the site's condition. On his report on the conformation of "Abras de Mantequilla" commonwealth, Ladino (2009) states that only the main parishes around the wetland have potable water service available, understanding this as the process of water filtering through chlorine.	The growth expectation for agricultural activity could be plausible as a hampering factor of the wetland's capacity to maintain its current thread of improving secure water storage capacity. Higher use of pesticides, herbicides and the occupation of riparian areas for agricultural use could be drivers for such an occurrence. According to projection and planning by CEDEGE, the hydrological system will be dramatically altered by massive dam construction projects upstream in the tributary and affluent rivers. This could directly impact the quantity and composition of the sedimentary material that inflows from upstream rivers, which in turn could unbalance current conditions and damage water quality in the wetland.	X	X
		Daily provision of secure water	Local consumption (domestic, commercial, industrial uses)		In terms of the population settled on the wetland's surroundings, INEC ECV-2006 reported that about 44% have eventual access to a drinking water supply. Only about 5% have permanent access to this resource. On his report on the conformation of "Abras de Mantequilla" commonwealth, Ladino (2009) states that only the main parishes around the wetland have potable water service available, understanding this as the process of water filtering through chlorine. These seems to justify that 66% percent of the households in the area report to assume some form of self-treatment (boiling/chlorine/filter/bottled water) on the water they consume. During workshops, local stakeholders repeatedly prioritized the role of the wetland in provision of secure water and food (agriculture and fisheries)	During workshops, local stakeholder perception of the potential of the wetland to sustain its current capacity as a secure water source was not as good as their current perception.	X	X

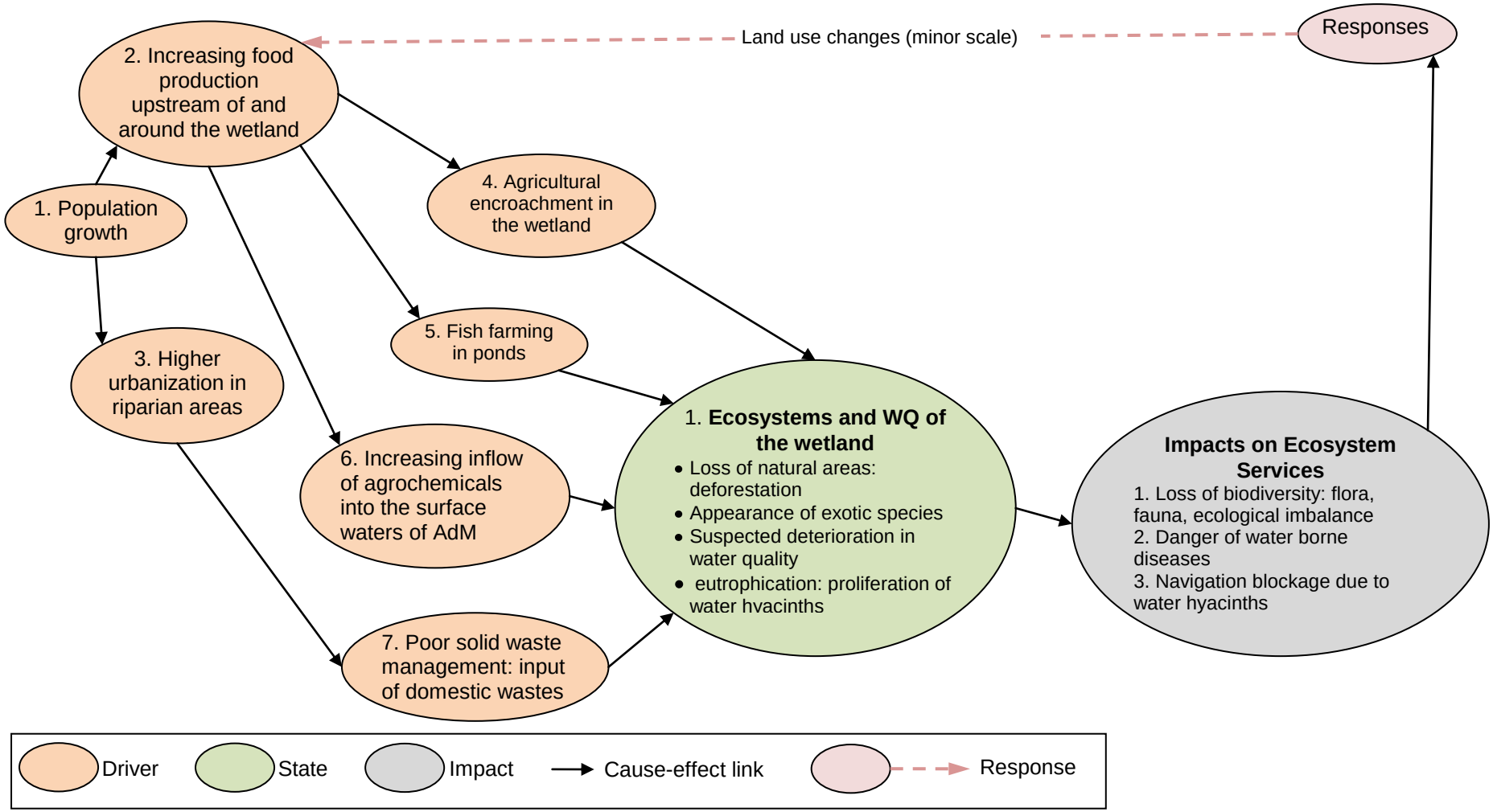
SERVICES			BENEFIT FOR:	TEEB icon	DESCRIPTION		BENEFITS DURING	
					present	future	wet season	dry season
Food production	Agriculture on the fertile soils of the flooding areas: rice and maize		Local Agricultural Productive Units (APU)		The main economic activities of the communities settled on the wetland are primarily related to agricultural activities, specially corn and rice crops, which are their main income source. According to the ECV 2006 26.93% of the total agricultural production in AdM uses organic fertilizers, 45.55% inorganic fertilizers and 56.59% pesticides. Local APUs state that they cultivate their rice crops using superficial well systems. In other words, when water resides, they exploit the exposed land surface to establish seasonal crops. In these new lands is where they use herbicides in order to raise their crops. The average APU produces in between 1364 and 2567 Kg of unprocessed rice and between 160 and 219 Kg of unprocessed corn. During workshops, local stakeholders stated their perception that the most important function of the wetland service provision capacity revolves around agriculture.	Incentives for agricultural expansion given by governmental and private organizations are likely to continue, which will effectively increase the number of Ha cultivated around the wetland. Population growth will also contribute to the expansion and diversification of crops, cultivated upstream of and around the wetland. In the future, local APUs project a conservative estimate of sowing around 10000 Ha which constitutes about half of the arable land for rice cropping in the wetland area. During workshops, local stakeholder perception of the potential of the wetland to sustain its current capacity to provide supporting services to agricultural activities was not as good as their current perception.	X	
	Fisheries and aquaculture	Functions of nursery/ spawning zone/species reproduction	Fisheries in the rivers of the Los Ríos province (due to hydrologic connectivity)		The ictioplantonic composition of river Vinces is constituted by larva and young fish, with a density of 160 larvas/m^2 and 1194 young fish per m^2 just in Palenque and Vinces communities all (which represent around 12% and 88% of total biomass). Stationally, during the wet season the egg, "pre-larva" and larva presence in the zone is noticeable. On the other hand, "pre-larva" and larva are practically non-existent during dry season, but fish eggs decrease dramatically. In Pallenque river, measurements shows 80 fish larva per m^2 with similar morphological characteristics shown by the Vinces river.	If the current trend continues, local biodiversity could be expected to suffer considerable loss unless proper measures are taken to alter these patterns	X	

SERVICES			BENEFIT FOR:	TEEB icon	DESCRIPTION		BENEFITS DURING	
					present	future	wet season	dry season
		Fisheries in AdM	Local consumption (mostly domestic, little commercial use)		A considerable adult fish supply is observed intriver lanes around the communities settled in the wetland. They belong to the Lebiasinidae family. The local stakeholders call this the Huaija or Anchoa, a species which length revolves around 7 and 8 cm. W. Rebello et. al. (2004) analyzed a total of 304 specimens from 9 different families (Curimatorbis Boulengeri or dica 26.3%, Brycondentex or dama 23.7%, Leporinus Ecuadoriensis 12.5%, Ramdia Cinerascense or barbudo 12.8%) During workshops, local stakeholders stated their perception that the second most important function of the wetland service provision capacity revolves around fisheries.	During workshops, local stakeholders showed a decreased interest in fisheries in respect to aquaculture in the wetland area. This responds to a perception of the need to introduce native fish species with this type of practice.	X	
		Aquaculture in AdM	Local consumption		not at all	During workshops, local stakeholders showed a decreased interest in fisheries in respec to aquaculture in the wetland area. This responds to a perception of the need to introduce native fish species with this type of practice.	X	X
	Natural wild products	Teak plantations	Local usage		(no data)	(no data)		
		Bamboo plantations	Local usage, environmental benefit		(no data)	(no data)		X
		Plant species of different interest (medicinal, plague control,…..)	Local usage		(no data)	(no data)		
	Navigation routes for transporting goods and people		Local people (farmers, fishermen)		During WETwin workshops, local stakeholders pointed a decline in the wetland's navigability. They identified the problem as a consequence of increased presence of water hyacinth in the area. Other workshops conducted by the Ministry of Environment (2003) confirmed this problem and declared a priority concern that falls directly under its jurisdiction	The problem will likely become more severe in the future	X	

SERVICES			BENEFIT FOR:	TEEB icon	DESCRIPTION		BENEFITS DURING	
					present	future	wet season	dry season
Cultural	Recreational	Local organization of community tourism	Local communities		In terms of local community organization, the ECV 2006 states that about 11% of the total population has participation on community action for income generation or food provision. Nonetheless, less than 1% percent of the population declares involvement in other types community action such as initiatives to participate in government aid programs, childcare, public good provision (like communal water boards), etc	During workshops, local stakeholders show increased expectations to exploit the wetland's touristic potential. They invision to intensify local community action to pursue this objective.	X	X
		Travel agency tourism	Agencies outside the zone		There is no record of any of private travel agency directly involved in the area. Also, the role of the Ministry of Tourism in the area is practically null, since it is not yet recognized as a protected area, nor does it generate a significant flow of tourism up to date. There are isolated community initiatives, especially in the "El Recuerdo" precinct spawned from small investments on good use and management practices in wetland area, promoted by the Environment Ministry.	(no data)	X	X

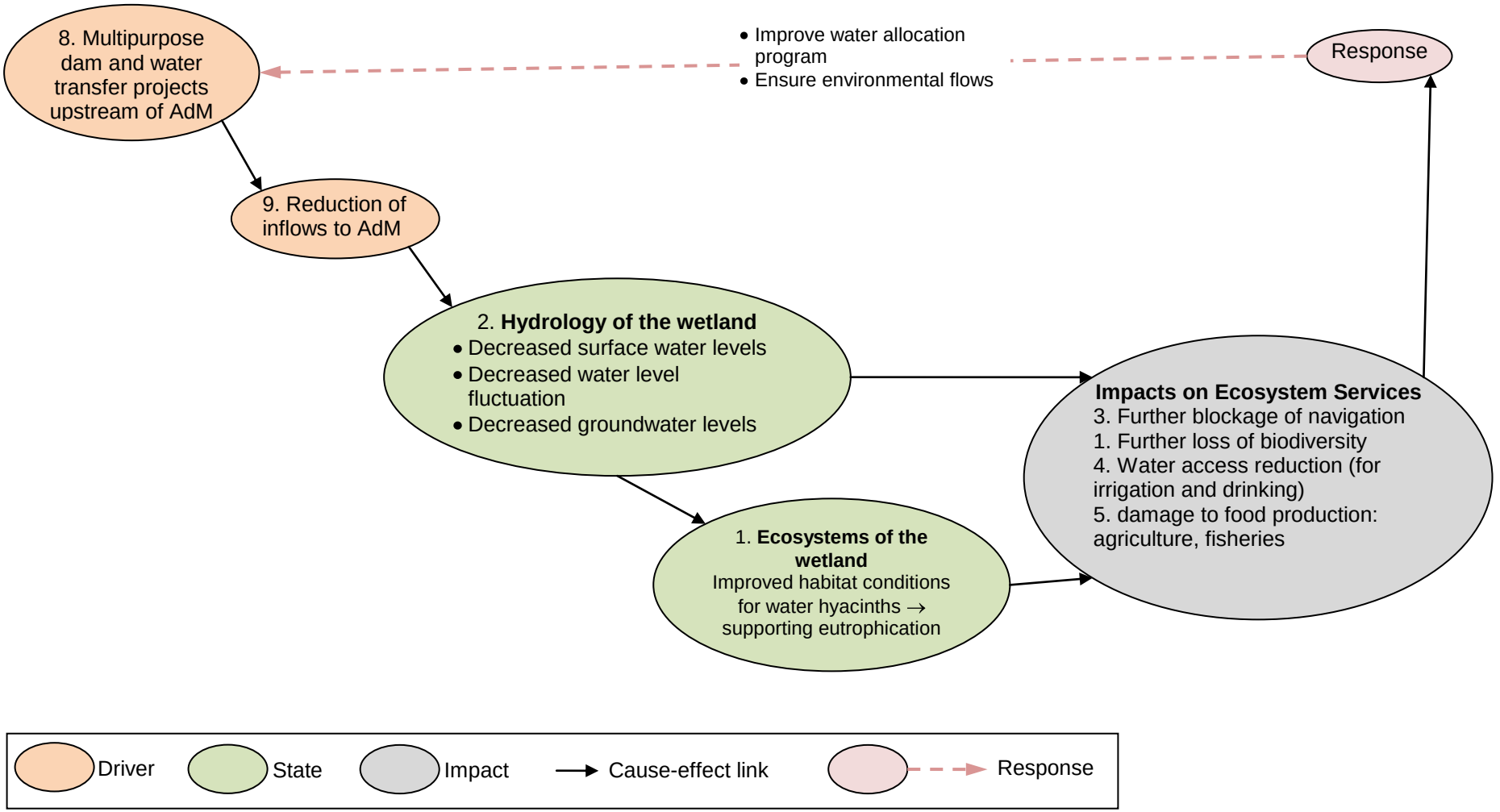
Source: presentation of M. Arias in the Mali project meeting (+ see references in the text)

4.4.3 Problem I.: Impacts of agricultural and urban development on the ecosystem services of AdM



Source: presentation of M. Arias in the Mali and Delft project meetings

4.4.4 Problem II.: Impacts of basin-scale river management and water allocation projects on the ecosystem services of AdM



Source: presentation of M. Arias in the Mali and Delft project meetings

4.4.5 Detailed description of the DSI components

DSI components		Spatial scales	Description	
			Present (+ near past)	**Future**
Drivers	Population growth	AdM + Guayas basin upstream	The wetland Abras de Mantequilla is located within the jurisdiction of 3 municipalities: • Vinces with an urban population of 31 738 and a rural population of 37 099 inhabitants and an annual growth rate of 1.6%. • Baba with a population of 39 342 inhabitants, mostly located on rural areas, and an annual growth rate of 1.6%. Its population is very young, as 45.4% of its inhabitants are bellow 20 years of age. • Pueblo Viejo with a population of 32 895 inhabitants, concentrated on rural areas, and an annual growth rate of 2.4%. Its population is very young, as 46.5% of its inhabitants are bellow 20 years of age. (Data taken from the Asociación de Municipalidades del Ecuador, 2008)	In ten years, the population of Vinces will reach the population of approximately 80679 inhabitants. Baba will reach a population of approximately 46110 inhabitants and Pueblo Viejo a population of approximately 41700 inhabitants.
	Increasing agriculture upstream of and around the wetland	AdM + Guayas basin upstream	The most important activity that the local populace does for a living is agriculture. Governmental and private organizations are giving incentives, in the form of financial credits, to promote the expansion of agricultural practices. Representatives of the Ministry of Environment pointed out that in the past, this area was used mostly for banana plantations, which was an endemic plant; but that this began to change with de division of the land provoked because of the growing number of families (banana plantations require large amounts of space to remain lucrative). People started to diversify their crops without careful planning and nowadays, maize and rice are mostly planted. According to the ECV INEC- 2006, 26.93% of the total agricultural production in the AdM utilizes organic fertilizers, 45.55% inorganic fertilizers and 56.59% pesticides.	Incentives for agricultural expansion given by Governmental and private organizations are likely to continue, which will effectively increase the number of ha. Cultivated around the wetland. Population growth will also contribute to the expansion and diversification of crops cultivated upstream of and around the wetland. In the future local APUs project a conservative estimate of sowing around 10000 ha. Which constitutes about half of the arable land for rice cropping in the wetland area.

DSI components	Spatial scales	Description	
		Present (+ near past)	**Future**
Higher urbanization in riparian areas	Banks of the AdM and upstream areas	In the banks of the AdM, approximately 136 houses are scattered around 70 000 hectares; which makes communication between houses and/or communities very difficult, especially during winter because of the number of floods. Given the average number of people per household in AdM wetland (4 people per household), the estimated annual growth rate of house settlements is approximately 0.4% (processed from ECV INEC-2006). There are several municipalities located upstream AdM but, in order to analyse the expansion of urbanization in rural areas, we will refer to the following: • Mocache, with a 2010 projected rural population of 31477 inhabitants and an approximated number of house settlements of 7869. • Ventanas with a 2010 projected rural population of 34321 inhabitants and an approximated number of house settlements of 8580. • Pueblo Viejo with a 2010 projected rural population of 24666 inhabitants and an approximated number of house settlements of 6166. • Palenque with a 2010 projected rural population of 17324 inhabitants and an approximated number of house settlements of 4331. (Processed from the INEC's 2001 Census and ECV-2006).	Due to in site population growth, higher urbanization in riparian areas is to be expected; but because of the relatively low density of houses in the area, this growth will not cause considerable damage in the system in the near future. In 10 years the number of riparian house settlements will be approximately 142 (an increase of 6 houses in 10 years). On the other hand, higher urbanization in upstream rural areas might prove problematic in the future, because of the growth of its population, but further projections won't become available until de 2010 census is completed.
Multipurpose dam and water transfer projects upstream of AdM	Guayas basin upstream of AdM	These projects haven't been implemented yet. They are either under construction or still just on plans.	The following projects (coordinated by CEDEGE) will be implemented: • A multi-purpose dam on the Vinces river upstream of AdM. This dam will generate hydropower, supply irrigation water, support flood retention and transfer water to the Daule river basin • Water transfer from the Vinces river to the Puebloviejo river right upstream of AdM • Dam inside the AdM

DSI components		Spatial scales	Description	
			Present (+ near past)	**Future**
Drivers	Agricultural encroachment in the wetland	AdM	The developing agriculture has occupied more and more natural areas in the wetland	Due to Increasing agriculture upstream of and around the wetland and the expansion of the agricultural frontier in higher grounds in the future (which causes an increase of sediments carried to the basin during rainy seasons), further agricultural encroachment is to be expected
	Increasing inflow of agrochemicals into the surface waters of AdM	AdM	The RAMSAR 2008 sheet indicated that the water quality indexes reported a 100% for NO3 and NH4. For PO4 the readings oscillated between 75% and 80%. For dissolved O2 the readings reported values above 80%. In all, the wetland system reports an acceptable water quality state for maintaining local bio-diversity. As matter of fact, these indexes reported an improvement from readings taken in June of 1981, which suggested an overall improvement in the site's condition.	There are a number of factors that could increase the inflow of agrochemicals into the surface waters of AdM in the future: • The low level of capacitation, given to the local farmers, in efficient agricultural practices. Because the Ministry of Environment and local NGO's financed initiatives to counter this problem have been both sporadic and specific, this problem is likely to continue. • According to the ECV INEC-2006, the average AdM farmer states that 33.25% of his total production of rice was used for consumption, while 1.35% utilized as an intermediate agricultural good; 7.71% of the production of soft maize is consumed and 3.19% of hard maize was used as an intermediate agricultural good. To maintain this rate of consumption in the future, the growth of the population forces the expansion of the agricultural activities in the area.
	Poor solid waste management: input of domestic wastes	AdM	In the AdM region, 51.47% of households have a cesspool for disposing waste, while 16.48% counts with a sewage system for waste disposal. Garbage disposal suffers from similar problems as 47.42% of the total number of households counts with municipal/public garbage disposal service but, in spite of this, 50.78% of the population disposes garbage by burning it or throwing it to the street/lot//river/stream or other places (Processed from the ECV INEC-2006). During workshops, local stake holders identified poor management of solid wastes as one of their primary concerns.	As the higher urbanization in riparian areas and its expected growth rate is very limited, the problem caused by poor solid waste management in these areas won't become more problematic in the near future. On the other hand, the expansion of rural upstream settlements, provoked by population growth, will increase the volume of solid wastes disposed improperly if local authorities fail to implement plans to improve the current capacities of the waste management systems. After the approval of the new Ecuadorian Constitution in 2008, River Basin Organizations gained a lot of strength, responsibilities and obligations. But until a number of legal loopholes are closed with the approval of New Water Law, it is difficult to predict how solid waste will be managed in

DSI components		Spatial scales	Description	
			Present (+ near past)	**Future**
				upstream and riparian areas
	Reduction of inflows to the AdM	AdM	Presently, reductions of inflows to the AdM are not considered a primary concern to local Stakeholders during workshops.	Considerable reduction of inflows is expected especially due to the planned water transfers. Additional reduction is expected during floods due to retentions by the dam.
	Fish farming in ponds	Guayas basin	Fish farming was started in the sixties in the area of Santo Domingo de los Colorados with Tilapia imported from Columbia. But because of the rupture of the pond's containment wall, most specimens escaped and spread over the basin.	
State	Loss of natural areas: deforestation	AdM	Erosion is attributable to deforestation because of the growth of agricultural activities and the radical changes in crops planted in the last years. Today maize is mostly planted and to do so, people have to deforest large areas and burn them down in preparation (Noroña 2009).	Future increase in agriculture upstream of and around the wetland → further loss of natural areas: deforestation, because of the techniques implemented to cultivate crops (especially maize).
	Appearance of exotic species	AdM	The exotic species of Tilapia has appeared in the AdM due to rupture of the containment wall of a fish pond in the the basin. Efforts have been made to halt their reproduction, like the chemical sex reversion of the Tilapia in the Guayas River Basin (refer to http://www.dspace.espol.edu.ec/handle/123456789/6341, Marcillo 2008).	
	Suspected deterioration in water quality	AdM	The RAMSAR 2008 sheet indicated that the water quality indexes reported a 100% for NO3 and NH4. For PO4 the readings oscillated between 75% and 80%. For dissolved O2 the readings reported values above 80%. In all, the wetland system reports an acceptable water quality state for maintaining local bio-diversity. As matter of fact, these indexes reported an improvement from readings taken in June of 1981, which suggested an overall improvement in the site's condition. On his report on the conformation of "Abras de Mantequilla" commonwealth, Ladino (2009) states that only the main parishes around the wetland have	INP today is working to collect data of water quality for the upstream river basins, but there is only one research station in the AdM area, which makes the data collected not very reliable for future predictions in the systems WQ.

DSI components		Spatial scales	Description	
			Present (+ near past)	**Future**
			potable water service available, understanding this as the process of water filtering trough chlorine.	
	Eutrophication (water hyacinths)	AdM	Water hyacinths are already quite abundant in the AdM	Habitat conditions of water hyacinth will become better due to the increasing nutrient loads and also to the expected hydrological changes → water hyacinth cover will likely increase
	Changes in hydrology		During field trips, river sedimentation was observed, to the point that some rivers like Pueblo Viejo have almost disappeared.	According to projection and planning by CEDEGE, the hydrological system will be dramatically altered by massive dam construction projects upstream in the tributary and affluent rivers. If the implementation of these projects is successful a potential change in AdM hydrology is likely to occur, because of the reduction in the amount of water that reaches the system.
Impact	Loss of biodiversity: flora, fauna, ecological imbalance	AdM	Isolated forests are undergoing a succession process, since they are not primary forests. They are in the course of recovering from anthropologic interventions. This confinement that the species in the area are subject off is surrounded by agricultural plantations. This has made genetic exchange between surviving species practically not feasible and may cause loss in local biodiversity due to the competition for this scarce resource and anthropogenic pressure. Due the insertion of the tilapia species, during workshops local stakeholders stated that fishery activities already show concerns since artisanal practices encountered a decrease in the amount of caught endemic species.	If the current trend continues, local biodiversity could be expected to suffer considerable loss unless proper measures are taken to alter these patterns. The planned dams on upstream will likely contribute to the loss of aquatic biodiversity unless measures are taken to compensate the impacts.
	Danger of water borne diseases	AdM	For children under 5 years of age (who are the most vulnerable group) water borne disease incidence ascends to 28.93%. Also, less than 10% of the local population has access to any form of health insurance, included IESS sponsored health service.	Since the current annual population growth rate for the AdM area is around 1.79%, population growth could intensify the problem in a midterm horizon.

DSI components	Spatial scales	Description	
		Present (+ near past)	**Future**
Navigation blockage	AdM	During WETwin workshops, local stakeholders pointed a decline in the wetland's navigability. They identified the problem as a consequence of increased presence of water hyacinth in the area. Other workshops conducted by the Ministry of Environment (2003) confirmed this problem and declared a concern that falls directly under its jurisdiction.	The problem will likely become more severe in the future
Water access reduction (for irrigation and drinking)		In terms of the population settled on the wetland's surroundings, INEC ECV-2006 reported that about 44% have eventual access to a drinking water supply. Only about 5% percent have permanent access to this resource. These seems to justify that 66% percent of the households in the area report to assume some form of self-treatment (boiling/chlorine/filter/bottled water) on the water they consume.	Since the current annual population growth rate for the AdM area is around 1.79%, population growth could intensify the problem in a midterm horizon. Also, according to projection and planning by CEDEGE, the hydrological system will be dramatically altered by massive dam construction projects upstream in the tributary and affluent rivers. This could directly impact the quantity and composition of the sedimentary material that inflows from upstream rivers, which in turn could unbalance current conditions and damage water quality in the wetland.
Damage to food production: agriculture, fisheries		During workshops, local stakeholders stated that fishery activities already show concerns since artisanal practices encountered a decrease in the amount of cached endemic species. They declared that tilapia presence in the wetland has replaced native species.	The expected decrease of the wetland's water resources will likely cause damages to agriculture especially to rice cultivation. Also fisheries will suffer due to the decreasing fish stocks

Source: presentation of M. Arias in the Mali project meeting (+ see references in the text)

4.4.6 Identification of tradeoffs between ecosystem services

Upstream water management (water transfer, storage, irrigation water supply)	**vs.**	Water quantity	→	Drinking water, irrigation, navigation in the wetland
	vs.	Purification and nutrient retention	→	Sanitation/drinking water downstream
	vs.	Water quality	→	Fishing, ecosystem health and equilibrium, eco-tourism
Agriculture	**vs.**	Water quality	→	Drinking water/eco-tourism
	vs.	Forest coverage	→	Ecosystem health and equilibrium, eco-tourism
Aquaculture	**vs,**	Water quality	→	Drinking water/eco-tourism
Urbanization of riparian areas	**vs.**	Water quality	→	Sanitation/drinking water downstream
	vs.	Forest coverage	→	Ecosystem health and equilibrium, eco-tourism

Source: conclusions of the Mali project meeting; information from G. Villa Cox

4.5 Ga Mampa wetland

4.5.1 Delineation of the Ga Mampa wetland and its catchment area

Map 1: Hydrography of the Mohlapitse river

Source: Chiron, 2005

4.5.2 Ecosystem Services of the GaMampa wetland

4.5.2.1 Habitat Services

HABITATS	BENEFIT FOR:	TEEB icon
Ecosystem health components are flora (reeds, sedges, etc) and carbon		

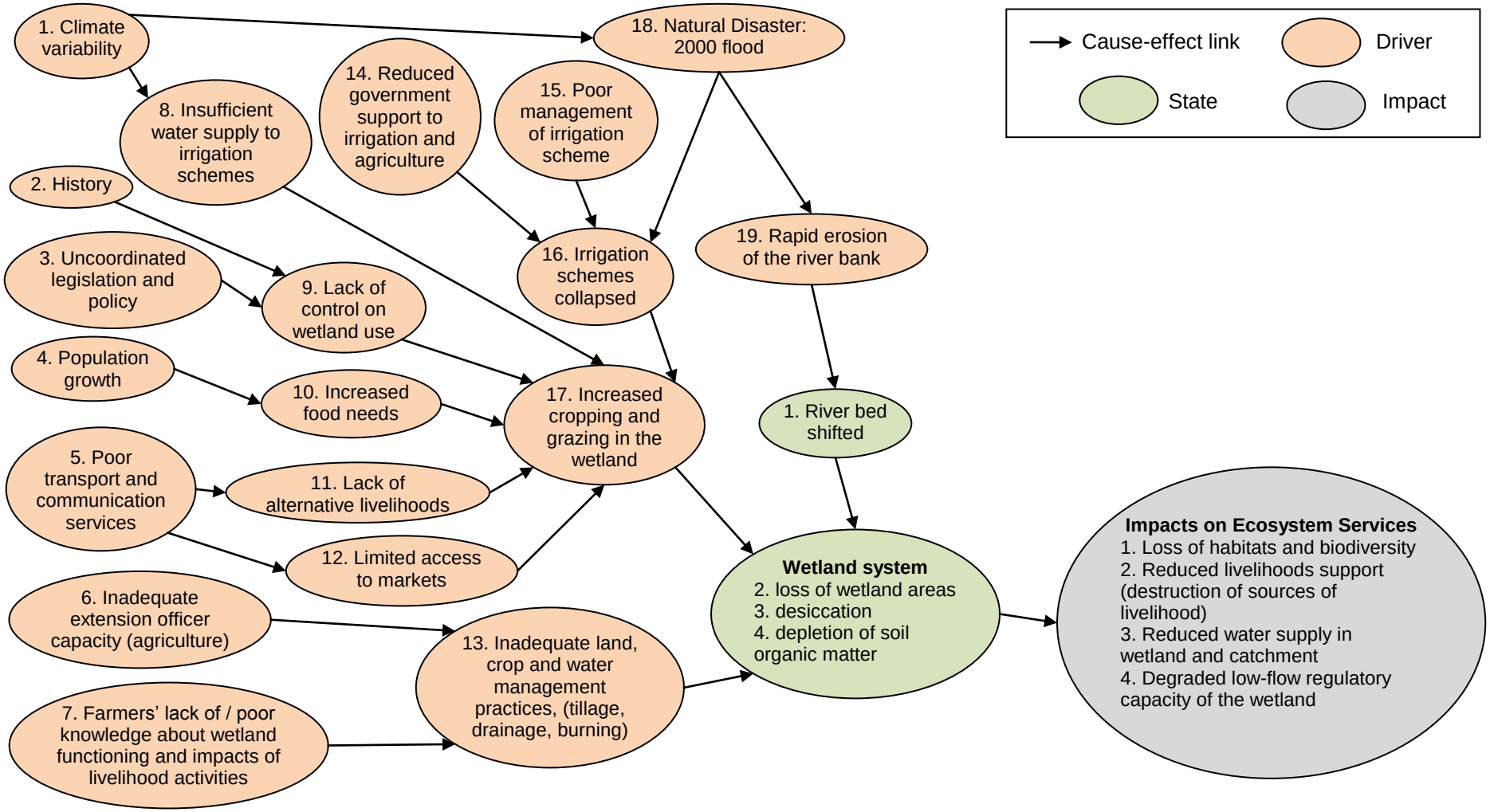
4.5.2.2 Regulating, Provisioning and Cultural Services

SERVICES			BENEFIT FOR:	TEEB icon	BENEFITS DURING	
					dry season (May-Sept)	rainy season (Oct-April)
Regulating	Hydrological regulation	Low flow regulation	Downstream water users: • irrigation • national parks (e.g. Kruger National Park) • international commitments		X	
		Flood attenuation	• Wetland communities • Communities immediately downstream of wetland			X
		(shallow) groundwater storage – water supply	Communities around the wetland using shallow groundwater for crop production and domestic water use during the time they are in the field		(sometimes)	X
	Carbon storage		Local community through increased fertility in the wetland and benefit for crop production		X	X
Provisioning	Food production	Crop production: maize in the rainy season; coriander and vegetables in dry season, sugar cane and banana all year round	Local crop producers		x	X (Crop production is much more important in the wet season than in the dry season because farmers do not know how to use residual moisture and groundwater in the wetland during the dry season)
		Livestock grazing	Local livestock owners		X	(sometimes)
		Fishing (in the river)	Local communities		X	X
		Harvesting edible plants. There are about 24 different types of edible vegetable plants (collectively known as “morogo” in Sepedi.) These are collected from the wetland and used to diversify diet. The major types are *Moshwe, Leshashe, Mshigi, Morotse and Bolotse*	Local communities		X	X

	SERVICES	BENEFIT FOR:	TEEB icon	BENEFITS DURING	
				dry season (May-Sept)	rainy season (Oct-April)
	Water provision	• Livestock owners • Farmers working in the wetland		X	X
	Material for community well-being: reeds (*Phragmites mauritianus*) and sedges (*Cyperus latifolis* and *Cyperus sexangularis*) used for building and crafting purposes, fuel-wood (?)	Local communities		X (harvesting)	
Cultural	Religious and cultural services: • there is a sacred place in the wetland, hosting a "magic tree", which is forbidden for any use. The custodian of the place is the headman • The wetland displays certain scenic beauty • GaMampa is on the African Ivory tourism route and is important for birding (to check which species), recreational hunting/fishing and outdoor (4x4 trail) activities	Local people, domestic and international tourists		X	X

Sources: Information from M. Masiyandima and S. Morardet; Adekola et al., 2007

4.5.3 Problem I.: Degradation of the GaMampa wetland



Sources: Information from M. Masiyandima and S. Morardet; Adekola et al., 2007; Tinguery, 2006; Darradi et al., 2005; Chiron, 2005; Murgue, 2010; Conclusions of the WETwin stakeholder meeting (15 April 2010, Loskopdam, South-Africa)

Detailed description of the DSI components:

DSI components		Spatial scales	Description	
			Present (+ past)	**Future**
Drivers	Climate variability	The whole Limpopo basin	The basin is prone to frequent droughts and floods.	Climate change is expected to increase the occurrence of extreme events in the basin.
	Insufficient water supply to irrigation schemes	Irrigation scheme next to GaMampa	In case of severe droughts, because of misconception of the water intake on the river, irrigation schemes do not receive adequate supply of water.	This will only improve if the irrigation schemes are rehabilitated
	Natural Disaster: 2000 flood	The whole Limpopo basin	Similar flood occurred in 1995	Flooding is a natural phenomenon in the Limpopo basin and may happen again in the future. With climate change, floods are likely to occur more frequently
	Poor management of irrigation scheme	Irrigation scheme next to GaMampa	Broken and leaky canals and excessive water loss from irrigation system. As a result there was inadequate water for crop production in the irrigation scheme and consequently low yields.	NA
	Reduced government support to irrigation and agriculture in general	National	In the early 1990's the government handed over all irrigation schemes to beneficiaries without the necessary transfer of skills or capacity building for the beneficiaries to be able to manage the irrigation schemes. (Previously the beneficiaries were like labourers on the schemes and did not make any management decisions). All financial support for maintenance of schemes has been removed.	The will to support the farmers is there but local government (provincial and municipal) seems to lack the capacity to support these farmers. For example, the irrigation scheme rehabilitation at GaMampa started five years ago but so far only the fencing of the plots has taken place. Agricultural extension services in South Africa are still in a poor state.
	Irrigation Scheme collapsed	Irrigation scheme	The flood in 2000 destroyed irrigation infrastructure (weir); interrupting water supply to the irrigation scheme plots. The weir has been rebuilt since but the state of the distribution canals is still very poor. Further, the canals conveying water to the plots are damaged, and have leakages. This reduces the efficiency of water delivery to the irrigation scheme. Consequently yields of the main staple crop (maize) remain very low.	Irrigation scheme may be revitalized; state of management not certain.
	Uncoordinated legislation and policy	National	National legislation dealing with wetlands: Restrictive: - National Water Act (Act 36 of 1998)	The institutional environment is changing. It will possibly improve, with better coordination. Gap between local / community management of wetland

DSI components	Spatial scales	Description	
		Present (+ past)	**Future**
		- National Environmental Management Act (Act 107 of 1998) - Environmental Conservation Act (Act 73 of 1989) Regulatory: - Conservation of Agricultural Resources Act (CARA) (1983). - National Environmental Management: Biodiversity Act of 2004 Traditional management - Traditional authority responsible for allocating land in commons but their legitimacy is decreasing. Water policy considers wetlands as source of water; agricultural policy regards wetland as agricultural resources that must be protected. Environmental policy is focused on protected areas and areas of national interest, and respect of SA's international engagements. Small scale wetlands such as GaMampa are not well taken into account in legislation and policy. There is a gap between local / community management of wetland and national level institutions and policies. Local elected governments have no mandate on natural resources management and their focus is on economic and social development and services delivery.	and national level institutions and policies can decrease
	History	National	Colonial history of South Africa, especially the apartheid era, may explain • the decrease of traditional authority legitimacy in managing natural resources, as some traditional leaders collaborated with the apartheid government, • the fact that local community people in the area do not easily accept external attempt to govern their way of using land and natural resources, because they have experienced forced removals in the past (they were chased out of the natural reserves upstream of the wetland) and were imposed agricultural practices (e.g. the betterment programme).	NA
	Lack of control of wetland use	GaMampa wetland	Wetland users are under the authorization control of the traditional authorities. There is no established Water user association in the area.	It is expected that a better coordination between the different line ministries and better awareness of municipal government and administration will increase

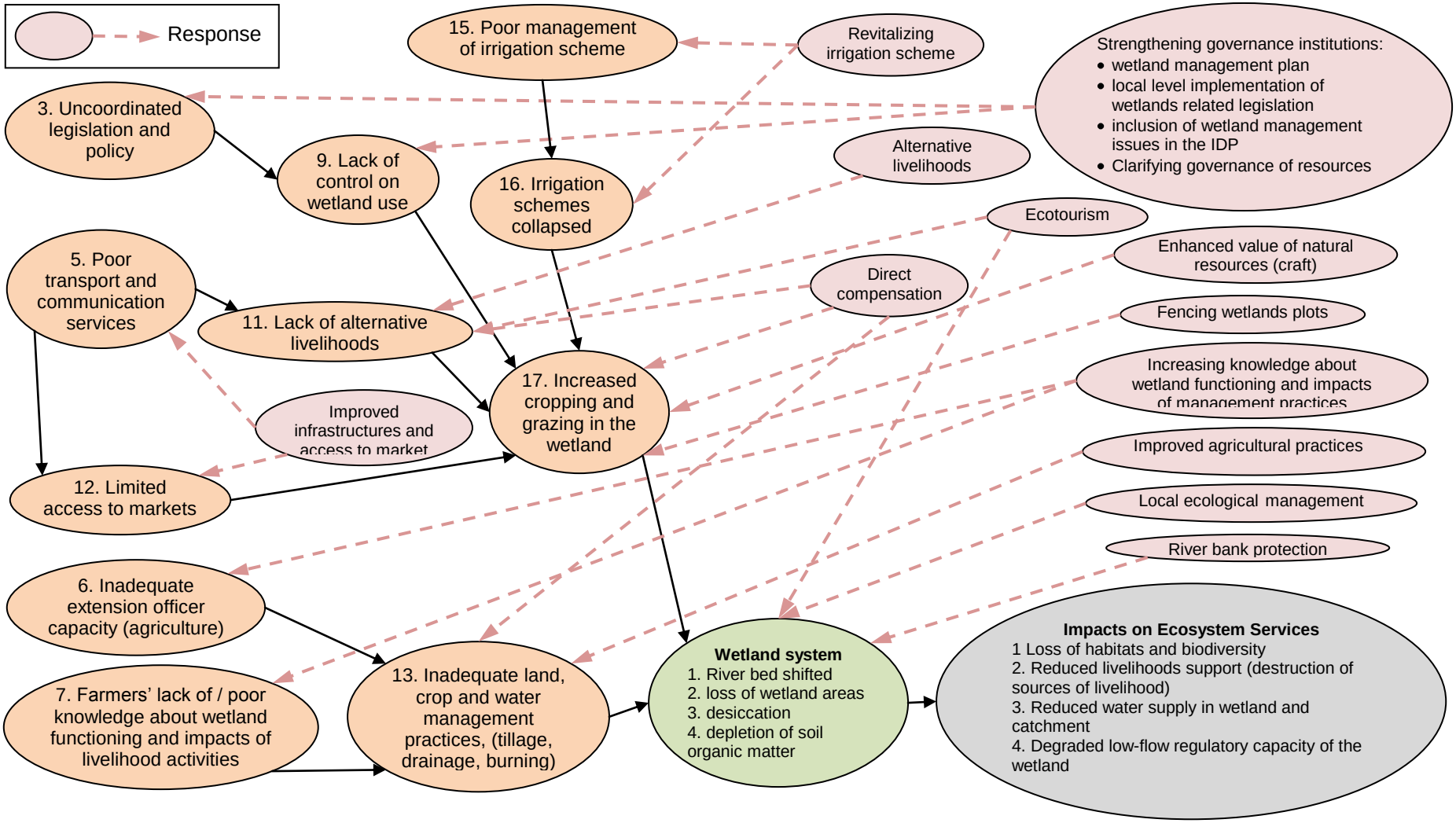
DSI components	Spatial scales	Description	
		Present (+ past)	**Future**
		There is no formal link between traditional authority and water user association in the legislation. Allocation of water between sectors is the responsibility of the catchment management agency which is not yet established in the Olifants river basin. In the interim, the department of water affairs is responsible of allocation of water but have no authority and limited means of control on traditional leadership. Like water governance, nature conservation and agricultural governance don't have direct authorization or administrative control on the wetland users and on the traditional authorities. The wetland is a common pool of resources with limited control on access and use and therefore a classic "tragedy of the commons" situation is occurring. There is no proper managing body for the wetland.	control on wetland use. The existing wetland committee could possibly develop in a full wetland management body.
Population growth	Neighbouring settlements	At present there are 394 households around the wetland. According to official sources the present population growth rate at district level is equal to 1.7% per year. However the picture is controversial as local informants have reported population decrease between 1996 and 2001.	Continued growth is foreseen; but emigration will also take place to the cities and mines as people look for alternative ways to earn income
Increased food needs	Neighbouring settlements	As population increases so does food needs.	Food needs are expected to grow at the same rate or even more rapidly than the population
Poor transport and communication services	Neighbouring settlements	GaMampa valley is very remote, located at 90km from the municipality offices. The last part of the road to the villages is not tarred and in a very bad condition. There is almost no cellphone network in the area.	The municipality is planning to extend the tarred road up to GaMampa and beyond to the R36, but the delay for completion is uncertain. The implementation of cellphone masts is part of the local municipality's IDP but again there is no indication when this will be done.
Limited access to markets	Neighbouring settlements	The distance from the main town, the only recent upgrading of the road and the absence of cellphone network make access to market for agricultural inputs and outputs very difficult. As a consequence, local households are maintained in a subsistence economy that forces them to seek for additional natural resources as the population grows.	It is expected that the further upgrading of the road and installation of cellphone mats will enhance market opportunities for the local agricultural production, thus increasing the value of agricultural outputs.
Lack of alternative	Neighbouring	GaMampa communities are poor; many depend on social transfers from the state and natural resource base. Alternative	No change foreseen unless there is state intervention

DSI components		Spatial scales	Description	
			Present (+ past)	**Future**
Drivers	livelihoods	settlements	livelihood options are limited by the poor transport and communication services	
	Inadequate extension officer capacity	Local	The extension officer of the Lepelle Nkumpi municipality can only give advises to the wetland users He/she doesn't have authoritative or administrative control on wetland use.	The situation will be changed only by government intervention aiming at capacity development
	Farmers' lack of / poor knowledge about wetland functioning and impacts of livelihood activities	Local	Limited capacity but increasing due to ongoing research and knowledge dissemination activities (e.g. by IWMI, UL) in the wetland	Research and knowledge dissemination likely to continue; capacity development will also continue.
	Increased cropping and grazing in the wetland	GaMampa wetland	Prior to the floods in 2000 there were about 12 farming households in the wetland. This number has increased to almost 100,	Pressure for cropping land is likely to remain if population keeps increasing, due to limited alternative agricultural land unless alternative livelihood options are proposed or emigration to urban areas keeps the population stable.
	Poor crop, land and water management	GaMampa wetland	Artificial drainage, active tillage, uncontrolled grazing of cattle.	A possible future scenario is that of improved local capacity and therefore improved crop, land, and water management
State	Wetland Ecosystem (Area, land use, water regime) • river bed shifted • loss of wetland areas • desiccation • depletion of soil organic matter	GaMampa wetland	As a result of the 2000 flood the river bed has been shifted and large wetland areas have been destroyed. The remaining wetlands have been cleared of at least 50% of natural vegetation for crop production. The remaining natural areas are suffering of desiccation, which has been caused by drainage. Desiccation has also caused the depletion of organic matter in the peat soils thus degrading further habitats and biodiversity. Trampling by livestock has caused compaction and erosion thus damaging biodiversity and habitats.	Loss of organic matter / peat and loss f nutrients. Wetland will be less productive in future. Further losses of wetland areas are expected as more and more households needing land in wetland
Impact	Loss of habitats and biodiversity	GaMampa wetland	Continued loss of habitats and species through clearing for agriculture and burning.	Increased loss in future due to pressure for agricultural land
	Reduced livelihoods support (destruction of	GaMampa wetland	Increased loss of natural products such as reeds, sedges as land is cleared for agriculture, as grazing is increased and as	Further losses in the future due to pressure for agricultural land

DSI components		Spatial scales	Description	
			Present (+ past)	**Future**
	sources of livelihood)		fertility is reduced. Loss of livelihood options derived from natural products.	
	Reduced water supply in wetland and catchment	GaMampa and catchment	Use of drains to lower water levels in the wetland to facilitate cropping. Drainage network density increases.	
	Degraded low-flow regulatory capacity of the wetland	wetland + downstream areas	(limited) low flow contribution by wetland	If business as usual mode; low flow contribution will diminish.

Sources: Information from M. Masiyandima and S. Morardet, Adekola et al., 2007; Tinguery, 2006; Dos Santos, 2009; Chiron, 2005; Ferrand, 2004; Kotze, 2005; Darradi et al., 2006; Murgue, 2010; Conclusions of the WETwin stakeholder meeting (15 April 2010, Loskopdam, South-Africa)

Potential Responses (for counteracting the degradation of the GaMampa wetland) and their interactions with the DPSI chain:



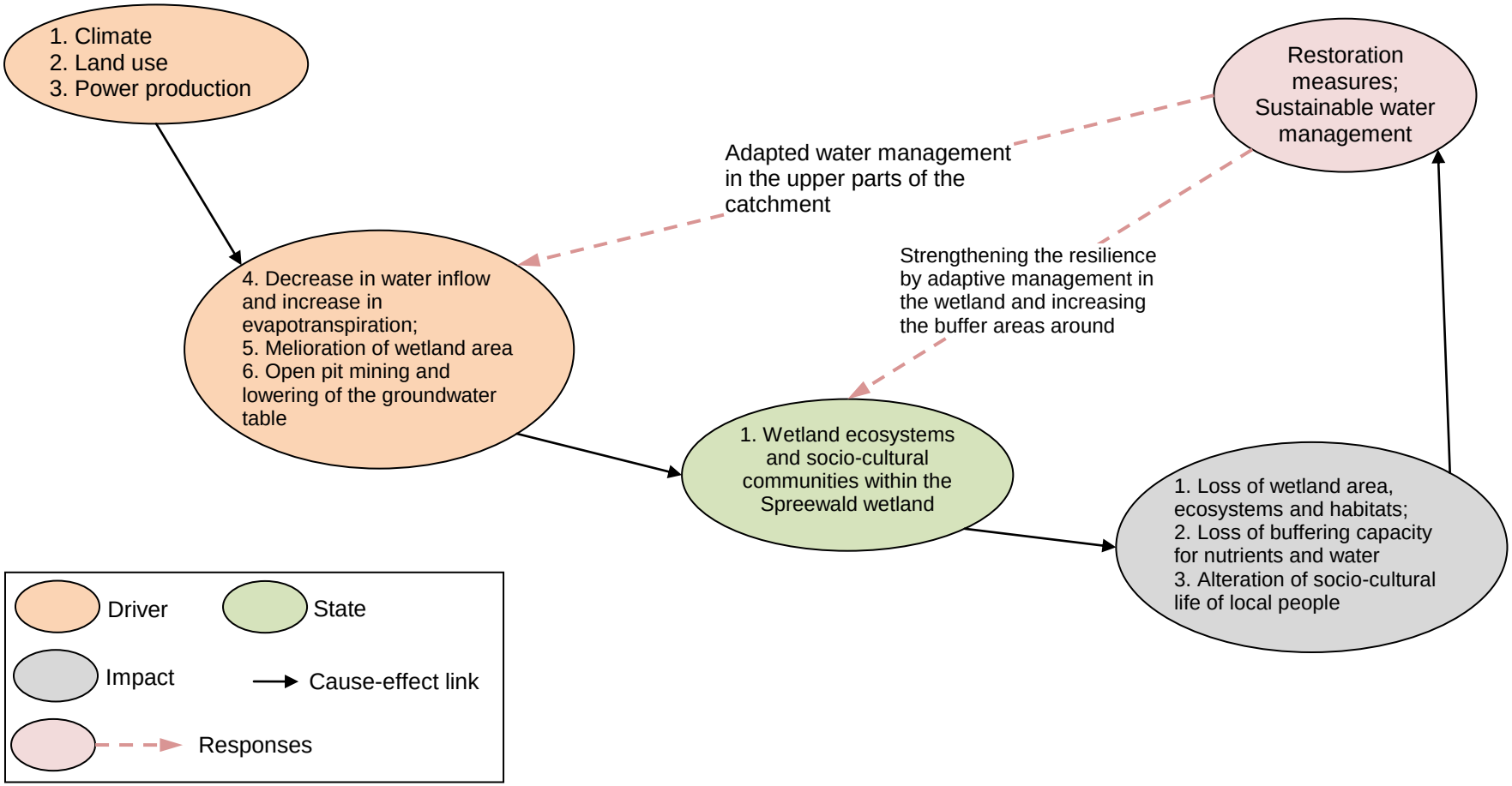
Source: Information from M. Masiyandima and S. Morardet; Murgue, 2010; Conclusions of the WETwin stakeholder meeting (15 April 2010, Loskopdam, South-Africa)

4.5.4 Identification of tradeoffs between ecosystem services

Water supply for food production	vs	water supply on site (e.g. for reed production)
Food production (on-site stakeholders)	vs	hydrological regulation, water supply downstream (off site stakeholders)
Food / crop production	vs	biodiversity
Livestock grazing	vs	cultivation

Source: Information from M. Masiyandima and S. Morardet

4.6 Desiccation problems in the Spreewald wetland

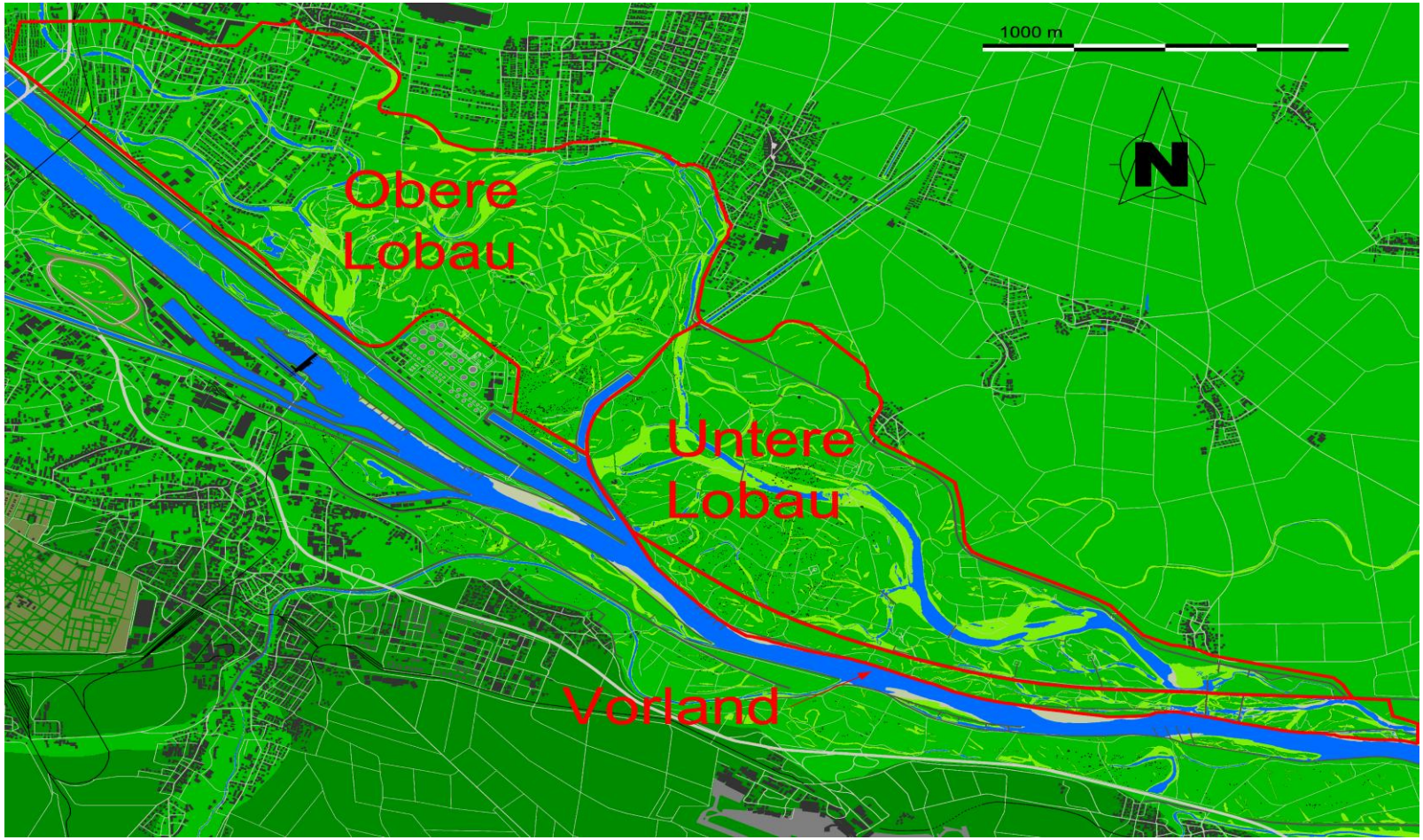


Impacted Ecosystem Services: Ecosystem Health, water regulation, fisheries, cultural

Source: Information from F. Hattermann

4.7 The Lobau floodplain

4.7.1 Delineation of Lobau floodplain



Source: OPTIMA Lobau, final report

4.7.2 Ecosystem Service of the Lobau floodplain

4.7.2.1 Habitat Services

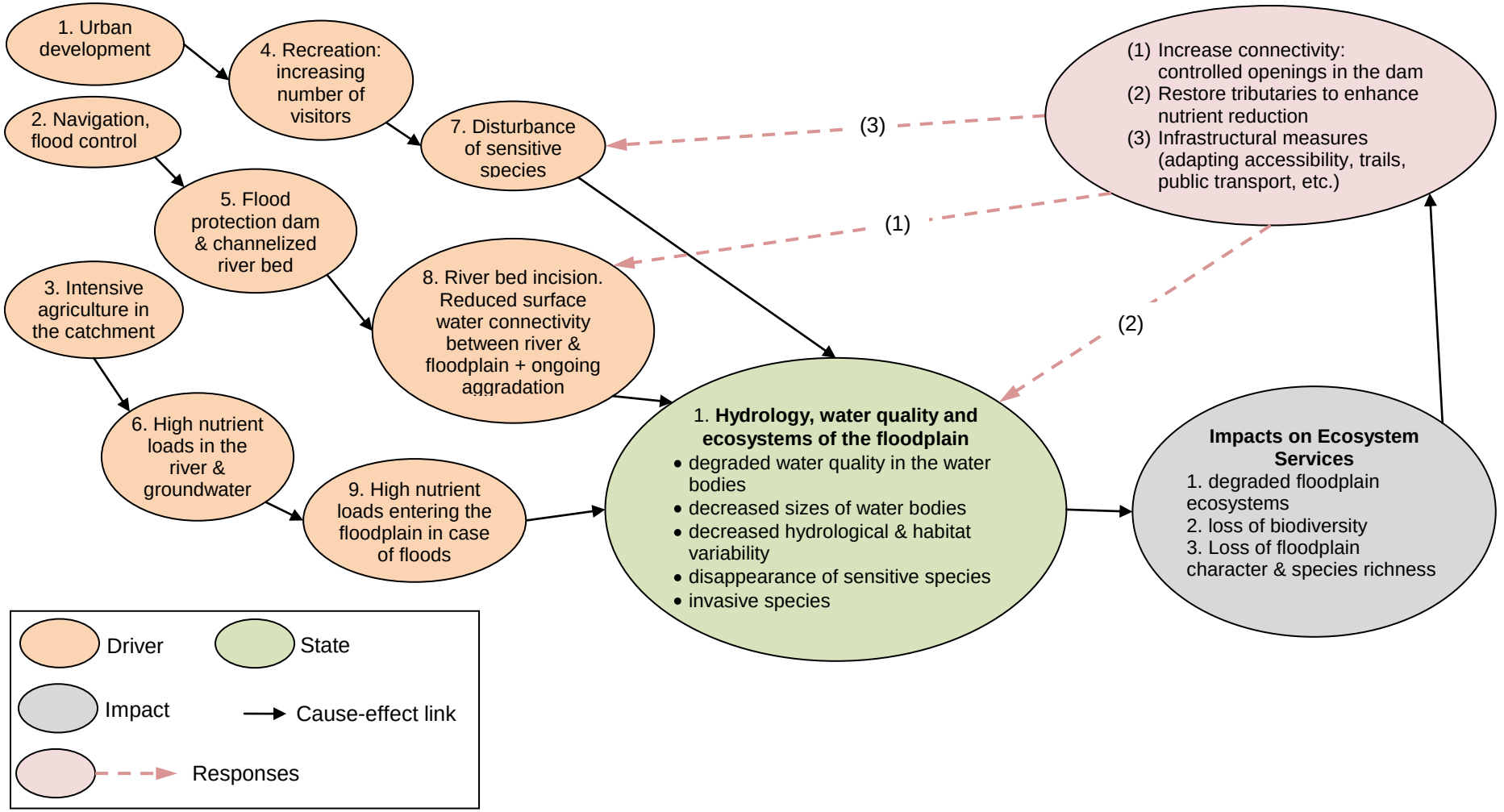
HABITATS FOR:		BENEFICIARIES	TEEB icon
Aquatic diversity	Phytoplankton, Zooplankton, Macrophytes	Ecosystem of the floodplain	
	Insect larvae	Ecosystem of the floodplain	
	Fish	Ecosystem of the floodplain, Danube River	
Terrestrial diversity	Terrestrial flora	Ecosystem of the floodplain	
	Terrestrial fauna	Ecosystem of the floodplain and adjacent areas	
	Bird species	Ecosystem of the floodplain, migratory bird comunities	
Habitat diversity	Spawning, nursery and feeding habitats for fish species	Fish stock of the floodplain and the Danube	
	Habitat for other aquatic species	Ecosystem of the floodplain	
	Habitat for rare terrestrial species	Ecosystem of the floodplain	
	Habitat for characteristic alluvial flora	Ecosystems of the floodplain	
	Habitat for migratory species (birds)	Ecosystem of the floodplain, migratory bird comunities	
	Creation of temporary pools	Ecosystem of the floodplain	

4.7.2.2 Regulating, Provisioning and Cultural Services

ECOSYSTEM SERVICES		BENEFICIARIES	TEEB icon
Regulating	Retention of high flows and mitigation of flood peaks	Areas downstream of the Lobau	
	Water purification by nutrient removal and retention	The whole downstream reaches of the Danube and the Black Sea	
	Climate Regulation and total water balance	Vienna, Marchfeld and other regions around Lobau	
	Matter Retention (during floods)	The Danube river channel	
	Processing of nutrients and organic matter (availability of nutrients for the food web)	Ecosystem of the floodplain	
Provisioning	Limited farming activities (to be terminated by 2020 due to national park regulations)	Local farmers	
	Sports fishery	Local communities, residents of Vienna	
	Hunting	Local community	
	Drinking water supply (5 groundwater wells)	Vienna City	
Cultural	Recreational activities e.g. bathing, camping, fishing, angling, canoeing, hiking and bicycling etc	Residents of Vienna, local communities, domestic and foreign visitors	
	Scientific and Educational	Local communities, schools and universities and scientific research communities from domestic and foreign	

ECOSYSTEM SERVICES		BENEFICIARIES	TEEB icon
	National and International Tourism and Eco-tourism	Private B&Bs and restaurants in the neighbouring settlements; Domestic and International visitors	

4.7.3 DSIR chain: Ecological degradation in the Lobau floodplain



Source: Poster prepared by T. Hein for the WETwin workshop in Ecuador

4.7.4 Detailed description of DSI components

DSI component	Description	Spatial dimension	Temporal dimension	
			Present (& past)	Future
Drivers	Need for navigation, flood control and hydropower	The Austrian part of the Danube Channel	Straightening and deepening of the Danube channel in the 19th century.	Navigation will increase
	Urban development	Expansion of the City of Vienna into the north western part of the Lobau, the Upper Lobau. In contrast, the Lower Lobau is a largely natural area.	The Upper Lobau is a highly urbanised floodplain which has entirely lost its natural floodplain character.	Further urbanisation is not expected due to protection of the Lobau by the National park laws. Development depends on the restoration measures to be carried out.
	Intensified Agriculture in the catchment upstream	Fertiliser use and subsequent runoff from agricultural fields leads to increased nutrient concentration in the Danube water which enters the Lobau in case of floods	Intense agriculture in parts of the Austrian and German Danube catchment	Future development depends on agricultural policies
	River regulation, channelization and constructions of flood protection dikes leads to river bed incision, reduction of connectivity between the main channel and the floodplain and a loss of ecosystem dynamics	The whole main channel of the Danube River	Heavily modified through flood protection measures occurring between 1830 and 1880, changed from a natural meandering river channel to straightening of the channel and subsequent loss of its side-rivers that was generated during high flows and flood events	Only minor changes are envisaged, e.g. deepening of the river channel for the purpose of navigation

	Increasing demand for recreational activities which hampers the maximum potential for ecosystem development and adds pressure on sensitive habitats	The whole area of Lobau Floodplain	During the summer months visitor pressure may become high (swimming, angling, waste disposal, disturbance of sensitive species), during the rest of the year it is moderate	Future development strongly depends on the envisaged management options, changing accessibility and hydrological regime
	High nutrient loads in the river which enter the floodplain in case of floods	The whole area of the floodplain	Intense agriculture in parts of the Austrian and German Danube catchment	Future development depends on agricultural policies
Change of State	Degradation of water quality of the water bodies	Water bodies within the whole floodplain	Water quality varies spatially and temporally	Depends on envisaged hydrological management measures
	Decreasing area and depth of water bodies	The whole floodplain	Very degraded state, many purely terrestrial areas	Strongly depends on envisaged hydrological management measures
	Decreased hydrological and ecosystem dynamics; decreased habitat diversity	The whole floodplain	Low hydrological dynamics (back flooded system), aggradation	Strongly depends on envisaged hydrological management measures
	Disappearance of sensitive species of the floodplain ecosystem	Key habitats in the floodplain		
	Appearance of invasive species	New macrophyte species in water bodies, Japanisches Springkraut in terrestrial areas at the edges of forests	Neophytes are present	Occurrence of neophytes will increase if aggradation goes on - depends on envisaged hydrological management measures

	Reduction of the capability of the floodplain to provide its services	The whole floodplain	Ecosystem health, nutrient reduction and flood control services are restricted at present	Will decrease if no measures are taken
Impacts	Changes in species diversity and distribution	The whole floodplain	Already altered species distribution compared to the historical state from 1830	Will continue if no measures are taken
	Loss of characteristic features of the floodplain	The whole floodplain	Characteristic features (e.g. high dynamics) are already lost	Will continue if no measures are taken
	Reduction of capacity to retain and purify nutrient loads	The Danube catchment downstream	Already restricted	Will continue if no measures are taken
	Loss of biodiversity and species richness	The whole floodplain	Already restricted	Will continue if no measures are taken

Sources: OPTIMA Lobau final report & personal conversation of the author Peter Winkler with Lobau specialists (Thomas Hein, Severin Hohensinner, Stefan Preiner, Elisabeth Bondar-Kunze)

Literature

Adekola, O., S. Morardet, R. de Groot, F. Grelot. 2007 The economic and livelihood value of provisioning services of the Ga-Mampa wetland, South Africa.

Alderlieste, M.C., J.G. Langeveld, 2005. *Wastewater planning in Djenné, Mali. A pilot project for the local infiltration of domestic wastewaters.* Water Science and Technology Vol 51 No 2 pp 57-64. IWA Publishing.

Asociación de Municipalidades del Ecuador AME.2008. "Mancomunidades Muncipales (mapas)", accessed from http://www.ame.gov.ec/frontEnd/main.php?idSeccion=9713, visited on 20 February 2010

AQUIFER, 2008. *Báta távlati vízbázis diagnosztikája.* (Diagnosis of the potential bank filtration water resources at Báta.) AQUIFER Kft.

Becker, A. (ed.), 2005. Model-*supported Participatory Planning for Integrated River Basin Management.* Deliverable No. D3/11-13 of Harmoni-CA project.

Beintema A.J., B. Fofana, A. Faye, H.P.J. Huiskes, 2005. *Flood forests of the Inner Niger Delta, Mali – past, present and future - .* Alterra-rapport 1316. Alterra, Wageningen.

Berthe A., B. Kone, 2008. *Wetlands and Sanitation – A View from Africa.* in : Ounsted M., J. Madgewick (eds.). Healthy Wetlands, Healthy People. Report of the Shaoxing City Symposium. Wetlands International.

Byaruhanga, A., S. Kigoolo, 2005. *Nabajjuzi Wetland System Ramsar Information Sheet.* NatureUganda, Kampala.

Chiron, D., 2005. *Impact of the small-scale irrigated sector on household revenues of the black community of Ga-Mampa Valley (Ward of Mafefe).* Contribution to the irrigation management transfer study of the small-scale irrigation schemes. Limpopo Province - South Africa. Master of Science, CNEARC.

Dam, A.A. van, A. Dardona, P. Kelderman, F. Kansiime, 2007. *A simulation model for nitrogen retention in a papyrus wetland near Lake Victoria, Uganda (East Africa).* Wetland Ecology and Management. Volume 15, Number 6.

Darradi, Y.; S. Morardet and F. Grelot, 2006. *Analysing stakeholders for sustainable wetland management in the Limpopo River Basin.* Proceedings of the 7th WaterNet/WARFSA/GWP-SA Symposium, 1-3 November 2006. Lilongwe, Malawi.

Denny, P., Whigham et al., 1993. *Wetlands of Africa.* Kluwer Academic Publishers.

Dos Santos, C., 2009. *Lecture de la gestion raisonnée des zones humides en Afrique du Sud : politiques, stratégies, contexte institutionnel et organisationnel pour une gestion intégrée.* Diplôme d'ingénieur agronome de spécialisation en agronomie tropicale et gestion sociale de l'eau, Institut des Régions Chaudes Montpellier SupAgro.

Edyegu, D. 2010. *Floods Retarding Border Demarcation.* The New Vision, 4. July, 2010. http://allafrica.com/stories/201007050165.html.

Ferrand, P., 2004. *Participatory diagnosis about farming systems and social management of water in the small-scale irrigation scheme of the Mashushu Community, Limpopo Province, South Africa.* Master of Science, CNEARC, University of the North, GRET.

Finlayson, C.M., D'Cruz, R. & Davidson, N.C. 2005. *Ecosystems and human well-being: wetlands and water.* Synthesis. Millennium Ecosystem Assessment. World Resources Institute, Washington D.C. (see also Ramsar COP9 Resolution IX.I Annex A. Ramsar Secretariat, Switzerland. Available at http://ramsar.org/res/key_res_ix_01_annexa_e.htm)

Fondazione Eni Enrico Mattei 2006. *DSS4 Decision methods.* Supporting document to mDSS version 4.1. Fondazione Eni Enrico Mattei, Venice, Italy.

IUCN, 2005(?). *Uganda wetland jewels.* IUCN.

Kalocsa, B., E.A. Tamás, 2004. *A folyamszabályozás morfológiai hatásai a Dunán.* (Morphological impacts of river training on the Danube.) BITE.

Kaggwa et al 2001, *Impact of alum discharges on a natural wetland.* Water Research.

Kansiime F., M. Nalubega, 1999. *Waste water treatment by a Natural Wetland. The Nakivubo Swamp,* Uganda, PhD Thesis. Francis & Taylor.
Kansiime F., Saunders, Loiselle, 2007. *Functioning and dynamics of wetland vegetation of Lake Victoria: An overview. Wetlands* Ecology and Management Vol. 15: No. 6, Dec. 2007, Pg 443 – 451.
Klinkenberg, E., F. Huibers, W. Takken, Y.T. Toure, 2002. *Water management as a tool for malaria mosquito control?* Irrigation and Drainage Systems 16: 201–212.
Koper, M., C. Mullun, Y. Poncet, E. Benga, 2003. *Integrated modelling of the ecosystem of the Niger river inland delta in Mali.* Ecological Modelling 164: 83-102
Kotze, D. C., 2005. *An ecological assessment of the health of the Mohlapetsi wetland , Limpopo Province.* South Africa:Centre for Environment, Agriculture and Development, University of KwaZulu-Natal.
Ladino, J., 2009. Various documents, "Proceso de Conformación Abras de Mantequilla". PRODER.
LNE, 2009. *SUIVI DE LA QUALITE DE L'EAU DES ZONES HUMIDES / DELTA INTERIEUR DU FLEUVE NIGER (MACINA , KOKRY, KOLONGO, MOPTI,YOUWAROU).* Laboratoire National des Eaux (LNE), Ministere de l'Energie et de l'Eau, Republique du Mali.
NatureUganda 2008. *Nabajjuzi Wetlands Ecotourism Development Project.* http://natureuganda.org/index.php?option=com_content&task=view&id=87&Itemid=30.
Marcillo, E., 2008. "Cultivo de Tilapia en el Ecuador", download at http://www.dspace.espol.edu.ec/handle/123456789/6341
Ministerio del Ambiente, ME (2003): Plan Piloto para el manejo de Abras de Mantequilla.
Ministry of Water, Lands and Environment (MWLE), 2004. *Nabajjuzi Community Based Wetland Management Plan (2004-2008).* MWLE.
Murgue, C. 2010. *Participatory analysis of tradeoffs between wetland ecosystem services in the GaMampa valley Limpopo Province, South Africa.* Research proposal. SupAgro, Cemagref, IWMI.
Noroña, M.B., 2009. Analysis of the decision making process in wetland management and the role of guidelines; Case Study: Abras de Mantequilla – Prov. Los Ríos, Ecuador. UNESCO-IHE.
OECD, 1994. *Environmental Indicators. Indicateurs d'environnement.* OECD Core Set. Corps central de l'OCDE. Organisation for Economic Co-operation and Development, Paris
Oyebande, L., A. Amani, G. Mahe, I. Niang-Diop, 2002. *Climate Change, Water and Wetlands in West Africa: Building linkages for their Integrated Management.* IUCN-BRAO working paper.
Pataki, B. 2009. *Assessment of wetland management structure and practice in the Gemenc wetland.* Input to WETwin deliverable D4.3: "Management practices and institutional setting" project report WETwin.
Quevedo Pinos, O. M Sc. 2008. Ramsar Sheet for the Abras de Mantequilla wetland, Ecuador.
Revelo W., E. Elias, P. Macías, M. Prado & J. Cajas. 2004. "PREDIAGNÓSTICO DE LAS CONDICIONES FÍSICAS, QUÍMICAS Y BIOLÓGICAS EN EL SISTEMA FLUVIAL DE LA PROVINCIA DE LOS RÍOS." Informe Técnico Instituto Nacional de Pesca Letamendi 102 y la Ría.
Soncini-Sessa, R. 2005. *Integrated modelling and participatory decision making in practice: The Verbano project. (in Italian)*. Mc Graw Hill, Milan (English forthcoming with Elsevier).
Tamás, E.A., B. Kalocsa, 2004. *A Rezéti-Duna feltöltődésének vizsgálata.* (Investigation of the aggradation of the Rezéti-Duna side branch.) BITE.
Tamás, E.A., Zs. Kempl, 2008. *A Duna hajózhatóságának javítása tárgyú projektet megalapozó tanulmány véleményezése.* (Opinion about the Preparatory study for the project on improving navigation conditions on the River Danube.) in: Gruber T. (ed.). Civil vélemény 'A Duna hajózhatóságának javítása tárgyú projektet megalapozó tanulmány' fejezeteiről. WWF Hungary.
TEEB, 2010. The Economics of Ecosystems and Biodiversity for Local and Regional Policy Makers. TEEB project document.

The Monitor, 2009. *Masaka Wetlands at Risk as 1,000 Encroachers Strike.* The Monitor, 4. November 2009. http://allafrica.com/stories/200911041073.html.
Tinguery, N., 2006. *The interface between the local community - based wetland resources management and the formal wetland policies, laws and institutions.* Case studies in South Africa and Zambia. Master, Brandeis University.
UNCSD, 1996. *Indicators of Sustainable Development Framework and Methodologies.* Commission on Sustainable Development. United Nations, New York.
Villa Cox, G., 2009. Socioeconomic descriptions of "Abras de Mantequilla" wetland and the Guayas River Basin, download at ftp://ftp.vituki.hu/wetwin/Internal/WETwin_documents/WP3/AdM_Db_Socioecomic_Assesment_Gonzalo_Villa_Cox/socioeconomic_report_AdM_Gonzalo_Villa_Cox.docx. ESPOL
Virág. L., G. Tornyai, L. Zellei, 2009. *GEF-DDNP Tápanyagcsökkentési Projekt, Kotrási munkák, mőtárgyépítés. Tervezési koncepció.* (GEF-DDNP Nutrient Reduction Project, Dredging works, constructions. Planning concept.) KEVITERV Akva Kft., EJF.
VITUKI, 2007. *A duna hajózhatóságának javítása tárgyú projektet megalapozó tanulmány.* (Preparatory study for the project on improving navigation conditions on the River Danube.) VITUKI.
VITUKI, VTK Innosystem, 2005. *Environmental Status Report (Environmental Assessment) Social Impact Assessment (Public Consultation)*, Reduction of Nutrient Discharges Project DDNP Component GEF # TF 051 289.
WETwin, 2008. *Grant Agreement, Annex I - "Description of Work".* WETwin project.
WHO, 2008. *Guidelines for Drinking-water Quality.*World Health Organization.
Wong, C., M. Roy, A.K. Duraiappah, 2005. *Connecting poverty and ecosystem services : A series of seven country scoping studies. Focus on Mali.* UNEP, IISD.
Wong, C., M. Roy, A.K. Duraiappah, 2005. *Connecting poverty and ecosystem services : A series of seven country scoping studies. Focus on Uganda.* UNEP, IISD.
WWF, 2008. *Inner Niger Delta flooded savanna.* in : The Encyclopedia of Earth.
Zsuffa, I. 2001. *Multi-criteria decision support for the revitalisation of river floodplains.* PhD thesis, Wageningen University, the Netherlands.
Zwarts, L., P. van Beukering, B. Kone, E.Wymenga 2005.*The Niger, a lifeline. Effective water management of the Upper Niger Basin.* ISBN 90-807150-6-9