Use of Casual Loop Diagrams and Systems Analysis to Explore Alternative Climate Change Adaptation Strategies in Seyhan River Basin, Turkey

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ABSTRACT

Within a UN Joint Programme titled "Enhancing the Capacity of Turkey to Adapt to Climate Change" a systems approach workshop was carried out in Adana, Turkey with broad stakeholder participation. The participants applied *systems thinking approach, causal loop diagramming methodology* and *systems analysis* to examine the potential impacts of projected climatic changes on natural ecosystems and socio-economical systems, as well as to explore the alternative adaptation strategies to cope with the potential negative outcomes of the climatic change in Seyhan River Basin.

This paper synthesizes the outcomes of this workshop, identifies major climate change impacts and clarifies the priority adaptation measures for managing climate change vulnerability in the Seyhan River Basin.

Availability and quality of water, and their implications for the region are considered to be the major priority area by the workshop participants. Results suggest that there is need for adaptive measures with an integrated water management perspective considering:

- Availability and supply of ground/surface water to maintain natural ecosystems, the goods and services they provide, agricultural productivity and food security;
- Efficient use of water for agricultural, residential and industrial purposes;
- Drought and flood management;
- Capacity building among the regional stakeholders in terms of climate change impacts and adaptation measures.

INTRODUCTION

In 2008, United Nations Development Programme (UNDP) has initiated and led a 4 years long UN Joint Programme titled "Enhancing the Capacity of Turkey to Adapt to Climate Change" with the participation of the Food and Agricultural Organization (FAO), the United Nations Industrial Development Organization (UNIDO), the United Nations Environment Programme (UNEP) and other stakeholders.

The main objective of the joint programme is to build capacity for managing climate change risks to rural and coastal development in Turkey. In order to achieve this objective, the project seeks to mainstream climate change adaptation into the national development framework, build capacity in national and regional institutions, pilot Community-Based Adaptation (CBA) projects in Seyhan River Basin, and integrate climate change adaptation into all UN agencies in Turkey.

With the pilot CBA projects, the Joint Programme expects to catalyse the up-scaling of the climate change adaptation priority activities in the Seyhan River Basin. It is also Joint Programme's intention to apply participatory methods and bring together key local stakeholders (planners and decision makers, developers and investors, local communities and most vulnerable groups) in the framework of public private partnership (PPP) to mobilize commitments and local resources in financing adaptation measures.

"Systems Approach" Workshop in relation to the Joint Programme

In order to build dialog and analysis in a participatory manner for local/regional experts, a workshop was carried out in Adana, Turkey on the 16-18 February 2009. Workshop participants consisted of 95 experts representing the local governmental institutions, universities and non-governmental organizations from three major provinces (Adana, Kayseri and Nigde) in the Seyhan River Basin. The intention with the workshop was to introduce **systems science** (i.e. *systems thinking, systems analysis* and *system dynamics*) to the participants and let them use of *Causal Loop Diagrams (CLDs)* to analyse the impacts of potential climatic changes on natural ecosystems and socio-economic sectors, and explore the alternative adaptation strategies to cope with the possible negative outcomes of the climatic change in Seyhan River Basin.

More specifically the objectives of the workshop were threefold:

- To introduce systems science to the local experts and civil servants in the region and demonstrate the way of holistic thinking;
- To clarify the inter/cross linkages and cause-effect relationships between the complex systems of climate, nature, economy and society; and
- To identify the priority themes/sectors/issues for which regional climate change adaptation strategies can be developed and financially supported under the Community-Based Adaptation Grants Programme

The workshop constituted a first attempt to provide the necessary platform for the regional experts to address climate change and discuss the feasible adaptation strategies.

For a better understanding of the complex and interrelated issues in relation to climate change in the region, it is essential to analyse the local dynamics/conditions in a systematic and holistic approach. Such an approach simplifies the complex structure and makes it possible to identify root-causes of particular problems, which can then allows the decision makers to develop proper measures/strategies/policies. For this reason, *systems science* (in particular *systems analysis*), an inter/cross disciplinary field of science for studying and managing complex feedback systems in nature and society, was introduced to all experts in the workshop.

Application of *systems analysis* in the workshop in a participatory manner is expected to have several benefits like identification of priority themes/issues to be financially supported under the Community Based Adaptation Grants Programme as well as demonstrating the local experts and civil servants the way of integrating/holistic thinking approach where they can use in their daily planning and decision-making work in the region.

This paper aims to synthesize the results of the systems approach workshop that was held in Adana and clarify the priority adaptation measures to managing climate change vulnerability in the Seyhan River Basin.

METHODOLOGY

Causal Loop Diagramming methodology along with *systems analysis* is used during the workshop.

Causal loop diagrams help to identify the linkages between different components in a complex system and show the cause-effect relationships and feedback loops within such a system (Richardson 1986).

Systems analysis is the interdisciplinary branch of science, dealing with analysis of systems and the interactions within those systems by creating mental model structures with the help of CLDs ideally over a series of *Group Model Building* (Randers, 1980; Vennix et al., 1992; Vennix 1995; Vennix, 1996; Andersen & Richardson, 1997; Vennix, 1999; Maani & Cavana, 2000; Sterman, 2000; Rouwette et al., 2002) workshops. More specifically, systems analysis helps i) identifying a problem/system; ii) developing a better understanding of the problem/system by clarifying the cause and effect relationships and the feedbacks between different components in a system; iii) building a conceptual model of the system at the root of the problem.

The conceptual model presented with a CLD, can further be developed into a dynamic numerical model (Coyle 2000; Maani & Cavana, 2000) with the help of *system dynamics* (Forrester 1961), which is a methodology used to understand the behaviour of complex systems over time. It deals with internal feedback loops and time delays that affect the behaviour of the entire system. With the

help of systems dynamics the mental model structures are taken into one step further and transferred into dynamic numerical models. Such models can be used as decision support tools enabling the user to generate different scenarios and analyse the associated simulation results. Even though the participants were briefly introduced to *system dynamics* methodology, they were not expected to use it during the workshop simply due to limited level of introduction and the time constraints.

CLDs that were developed during the workshop and presented in this paper do not tell the reader how strong each of the linkages are. Neither the functional form that the relationships take. Instead, they clarify the potential problems related to climate change and to formulate potential climate change adaptation measures/strategies in Seyhan River Basin. With the analysis of CLDs presented in this paper, the intention is to help decision makers (i.e. joint UN bodies) to decide what kind of projects they should financially support within the Community-Based Adaptation Grants Programme, in order to develop potential climate change adaptation strategies/measures within these priority areas.

In the CLD given by Figure 1 (and in all other CLDs constructed by thematic groups as given in Appendix 1), the arrows that link each variable indicate places where a cause and effect relationship exists, while the plus or minus sign at the head of each arrow indicates the direction of causality between the variables when all the other variables (conceptually) remain constant. More specifically, the variable at the tail of each arrow causes a change in the variable at the head of each arrow, all other things being equal, in the same direction (in the case of a plus sign), or in the opposite direction (in the case of a minus sign). The overall polarity of a feedback loop (Richardson 1995) - that is, whether the loop itself is positive or negative - in a causal loop diagram, is indicated by a symbol in its centre. An "R" sign indicates a reinforcing loop (or equivalently known as positive feedback loop, which is shown with a large plus sign) and a "B" sign indicates a balancing loop (or negative feedback loop shown with a large minus sign). In a reinforcing loop the action of the loop is to influence the parameter in the same direction as it is already moving (a destabilizing influence). On the other hand, balancing or negative feedback loops tend to return the parameter to its initial value (a stabilizing influence). In fairly complex systems, there are a substantial number of feedback loops, all of which result in a complex system behaviour. A model description of the CLD form does not contain all the detail necessary for a full understanding of the model's behaviour, but it is possible to identify cause and effect relationships, and reinforcing and balancing loops.

Causal Loop Diagramming in different thematic groups

After providing the general knowledge about systems science, participants were asked to work under 7 different thematic groups in a participatory manner and create *Causal Loop Diagrams* (CLDs) of the 7 themes, which were decided based on the earlier IPCC's studies. These themes include;

1. Water Resources and Quality
2. Agriculture and Food Security
3. Natural Resources Management
4. Natural Disaster Management

5. Public Health
6. Infrastructure
7. Management of Catchment and Coastal Areas

The participants were encouraged to work with people from different background/organisations/departments in order to elicit a range of diverse perspectives on each of the 7 themes. The main intention with the development of CLDs for each of the above themes were twofold; i) to develop a better understanding of the complex climate-nature-economy-social systems and their interactions with each other; ii) to deepen and share information about the likely impacts of climate change on various sectors as well as associated feasible adaptation strategies in the Seyhan River Basin.

During the first day of the systems approach workshop, each thematic group worked separately to construct their own CLD. Their attempt to construct CLDs, gave them opportunity to share the existing – and build new – knowledge on previously performed climate change impact and vulnerability assessments. Further more, they had the chance to brainstorm and come up alternative climate change adaptation measures/strategies for the basin. By the end of the day, all groups finalized their work with a general consensus among the all group members.

During the second day of the workshop, each thematic group presented the final version of their CLDs as their conceptual models, and explained the important components as well as the cause-effect relationships between these components.

RESULTS AND DISCUSSIONS

This section contains synthesises and analyses of the results of the 7 thematic group's CLD works. For each of these group's CLDs see Appendices.

CLD Presentation and identification of priority issues

By applying systems analysis and causal loop diagramming methodology with a participatory approach, the workshop participants were able to identify key systems drivers and examined perceived priority issues, which they all had a general consensus on.

CLD presented by Figure 1, is an attempt to combine all individual CLDs of thematic groups into a complex whole. It contains a rich amount of information about the climate change induced issues and their interactions with each other in the Seyhan River Basin.

Based on the results of the thematic working groups (i.e. causal loop diagrams that each group constructed and general discussions during the entire workshop period), Figure 1 suggests that **climate change** (i.e. increased **temperature**, decreased **precipitation**, more frequent **extreme events**, and **seal level** rise) will have significant direct impacts on natural systems (e.g. **biodiversity** loss, increased **forest fires**, changes in **hydrology**), and socio-economical sectors (e.g. increased **energy demand** for cooling, **health** problems due to extreme heat etc.).

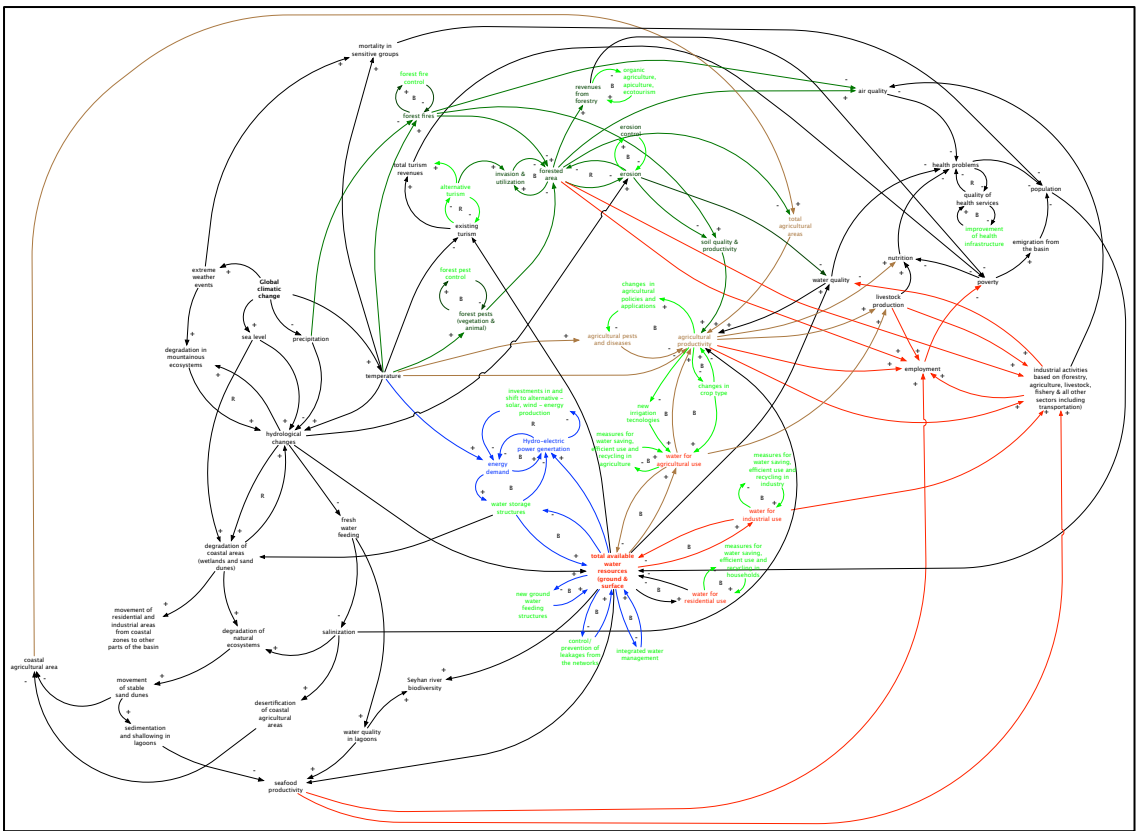

Figure 1. CLD of the climate change related issues in Seyhan River Basin

Climate change will also have several indirect impacts, which will occur not only due to less **water availability** in the basin, but also because of increased **erosion** and **agricultural and forest pest and diseases** etc. Scarce **water** will generally have a negative effect on the **agricultural productivity**, which will in turn negatively affect the **socio-economic system** (public health, industry and trade, employment etc.) in the Seyhan River Basin.

CLD given by Figure 1 also presents the suggested **adaptation measures** (i.e. **new irrigation technologies** and **effective water management**, **use of alternative energy resources**, **improved health infrastructure** and **alternative tourism**) to manage such negative impacts of the projected climate change in the area.

Water resources and quality

According to the results of the thematic groups' CLD work, **water availability** and **water quality** in Seyhan River Basin are expected to be highly vulnerable to projected changes in the regional climate system. As a result of **changes in hydrology** a potential decrease in surface runoff would have a negative effect on the **availability of water resources**, which will limit the **water use in agricultural**, **residential** and **industrial sectors** in the Seyhan River Basin. The results also suggest that it is not only the decreased **amount of water**, but also worsen **quality of the available water** (mainly due to decreased **amount of water** and increased **erosion**) that will generate problems in the Seyhan River Basin.

During the dry season, projected increases in **temperature** and decreases in **precipitation** over the Seyhan River Basin is likely to cause a decrease in the **supply of water** and **soil moisture**. This will worsen the stress on the **available water resources** and decrease the use of water for **agricultural** (e.g. **irrigation**, **livestock production**), **residential** and **industrial** purposes.

Hence, **water availability** and **quality** will require priority attention to secure sustainable development and to avoid any inter-sectoral water conflicts in the Seyhan River Basin. In order to cope with the future water related problems in the region, there will be a need for transition to **new adaptive water management** measures/strategies.

Construction of new **water storage structures** (both above and underground, and up and downstream), **master planning** and minimisation of **leakages** from the main water distribution networks, were some of the suggested measures to increase the amount of total **available water resources**. As a part of an effective **water management**, **erosion control** was suggested to improve the **water quality**.

More specifically, some of the suggested measures for **saving**, **efficient use** and **recycling** of water in agricultural sector, which in turn will decrease the **amount of water used in agricultural production** include;

- use of drainage water
- desalinisation and use of sea water
- promotion of night irrigation
- terraced slopes and rainwater harvesting methods
- capacity building on best practices for irrigation management and techniques i.e. drop and/or pressurised irrigation systems and their maintenance
- enforcement of regulations on "better agricultural applications"

Similarly, measures for **saving**, **efficient use** and **recycling** of water in residential and industrial sectors to decrease the **amount of water for residential use** include;

- Increased **awareness** in general public and industry for **efficient use of water**;
- Renewal of drinking water network to prevent leakages;
- Recycling of household and industrial waste water;
- Protection of drinking water catchments;
- Use of **eco-efficient technologies.**

Agriculture and food security

Agriculture is one of the major sectors in Seyhan River Basin and it plays a crucial role in the **provision of food** to the population in the region as well as other parts of the country. Negatively affected **agricultural productivity** (i.e. due to both the shorter duration of crop growing period and the agricultural

calendar) will have serious impacts on the level of **food production** and **food security** in the region/country. In addition, potential decrease in yields would have a significant effect on **agricultural trade** and **industrial activities,** which will generate **employment** problems. This will certainly have a negative effect on the **economic growth** and **development goals** of the region.

Higher **temperature** may result in increased **agricultural pests and diseases** in the Seyhan River Basin. This will affect the **agricultural productivity** negatively. Crops with weakened resistance due to direct **heat** stress conditions will be vulnerable to such **pests and diseases**.

Some of the key adaptive measures to cope with the negative impacts of climate change on agricultural and livestock production include;

- use of alternative irrigation systems e.g. **dripping irrigation** to increase the **available water for agricultural use**;
- introducing new **crop types** and **products** that are more suitable to the new climatic conditions in the region;
- **animal** and **pasture improvements**;
- **capacity building of farmers**.

Some of the main barriers to adaptation measures were identified as;

- difficulties associated with changing the traditional way of farming practices;
- inconsistency between agricultural policies and new applications;
- lack of support and resources for potential new industrial sectors based on new agricultural applications;
- modernisation of agricultural instrument equipment and its adaptation;
- opportunism in irrigation sector (associations, cooperatives etc.);
- difficulties in processing and marketing new products

Workshop participants discussed also the possible ways of achieving these barriers. Some of the actions include;

- education of technical person for spreading the knowledge;
- capacity building of farmers;
- improved incentives for new products and agricultural support;
- ease of bureaucracy;
- establishment of regulatory units for purchasing new products;
- marketing of new products to the consumers;
- encouragement of use of new methodologies and tools for protection of soil and water resources;
- effective coordination of all regional stakeholders (universities, public, private, NGO) in relation to agricultural sector;
- construction of new water storage structures upstream and downstream by the associated organisations;
- support for R&D in relation to improvement of agricultural products and processing technologies

Public health

Climate change will have a wide range of impacts on **human health** in Seyhan River Basin. Increased **temperatures** may lead to an increase in the **frequency and duration of heat waves** in the region, which may in turn increase the risk of **mortality** in some the vulnerable groups (i.e elderly people population).

Increased **temperatures** may also lead to an increase in **respiratory and cardiovascular diseases** in the region. Even more serious human health implications may occur in the Seyhan River Basin in case of **vector-borne diseases**, such as malaria and dengue fever appear in the region as a result of increased **temperature** and changes in the **precipitation** patterns. Similarly, **water-borne diseases**, such as cholera and the diarrhoeal diseases caused by organisms such as giardia, salmonella and cryptosporidium, could become more predominant in the region as a result of increased **temperatures**.

The workshop participants suggested an **improved**, **protective** and **preventive health service** as a major adaptive measure for the Seyhan River Basin.

Natural resources – ecosystems and biodiversity

During the systems approach workshop, the thematic groups have highlighted the profound negative effects of climate change on natural resources, ecosystems (i.e. freshwater ecosystems, wetland ecosystems, forest ecosystems etc.) and biodiversity in such ecosystems in Seyhan River Basin.

Changes in climatic conditions in the region, more specifically increased **temperature** and decreased **precipitation**, are expected to have impacts on the **forested areas** and the **forest productivity** in the Seyhan River Basin. In addition to direct impacts of climatic changes on the **forest productivity**, and **species distribution** and **boundaries**, some indirect impacts of climate change are expected on **forest ecosystems** due to the increased amounts of forest **pests and diseases** and frequency of **forest fires**.

Increased **sea levels**, high **temperatures** and low **precipitation** patterns are expected to cause **hydrological changes** in the Seyhan River Basin. Such hydrological changes will in turn cause increased **degradation in coastal areas** including **wetland ecosystem** and **sand dunes**. This will result in loss of rich **biodiversity** in **wetlands**.

Adaptive measures in relation to these natural ecosystems include **monitoring of water quality**, **supply of minimum water needed for wetland ecosystems** and **protection of biodiversity**.

Adaptation measures to cope with the negative outcomes of climate change on forestry general include;

- effective collaborations of associated bodies to prevent forest fires;
- capacity building of forest villagers;
- efforts to increase revenues from forestry products i.e. alternative ways for living and incentives for forest villagers (eco tourism, organic agriculture, apiculture, greenhouse etc.);

- updating of existing regulation and legislations;
- increased number of groups with an organisational structure (i.e. cooperatives);
- increased dialog and co-ordinations between associated bodies/units

Other adaptive measures in relation to water resources include;

- education, capacity building;
- efficient use of water in all sectors;
- changes in water use and agricultural policies

Main barriers to above-mentioned measures include lack of equipments, facilities, labour force, legal issues and high costs.

Management of catchment and coastal areas

Increased **sea level** together with increased frequency and severity of **extreme events** (e.g. storms, heavy rains) will have a negative impact on **coastal** and **low-lying delta areas** of the Seyhan River Basin. Such areas will suffer from **saltwater intrusion** and **siltation**, which will in turn lead to a loss in the **agricultural land** and the **productivity** on these areas. Increased **sea level** will also decelerate **wetland renewal** and threaten the rich **biodiversity** of wetlands.

With **sea level rise** and **increased coastal degradation** there will be increasing **changes in settlement patterns**, which may result in diverse social outcomes including economic implications (e.g. insurance, higher housing and living costs etc.)

The thematic groups suggested **management of coastal areas** incorporating dune management, and coastal settlement/development as an adaptive measure to deal with the climate change impacts on catchment and coastal areas.

Lack of data, awareness, financial support and insufficient regulation and legislations, and poor collaboration/communications between associated bodies/units are some of the expected barriers to adaptation efforts.

Climate change related disaster management

Changes in the seasonal **precipitation patterns** may increase the occurrence of **floods**, which will have severe **environmental** (biodiversity loss, decreased soil productivity and desertification upstream, loss of agricultural land etc.) and **socio-economic** (loss of life and property, increased epidemic diseases, reduced revenues from agricultural activities etc.) impacts in the Seyhan River Basin.

Moreover, **avalanches** may increase in the region due to quick and early melting of snow with higher levels of **temperatures**. Decrease in soil and air moisture due to increased temperatures will increase the risk of **forest fires**. A decrease in the forested areas will decrease the revenues from forestry products, but at the same time it may increase the agricultural and livestock production areas and associated incomes.

Other disasters like **drought, soil erosion, epidemic diseases, storms** and **landslides** are expected to occur more frequently with the changes in the regional climatic system.

Droughts will have a negative impact on the amount of **available water** and the **water quality** in the region. Increased **biodiversity** loss in wetlands and higher **forest fire** risks are possible outcomes of droughts in the region. Having less **water** in the basin will lead to increased **costs for water supply**, which will eventually be reflected to the end users as increased **water prices**. As a result of decreased **use of water in agricultural** and **residential sectors**, there will be a decrease in the **agricultural productivity** and an increase in **epidemic diseases**.

As adaptive measure, there is a need for well and effective organisation in order to stay prepared to respond to natural disasters. This requires a **disaster management** with proper monitoring and early warning systems.

Lack of necessary equipment/instruments, facilities, labour force, legal issues and high costs were some of the barriers pronounced during the workshop.

Infrastructure

It is highly possible that **electric energy demand** in the region may increase as a result of, for example, increasing demand for **air conditioning** and **irrigation**. At the same time, it is also very likely that **electricity production from hydro sources** will decrease with **increasing water shortages** in the region due to projected **high temperature** and **less precipitation patterns in the region**.

Infrastructure improvements to increase **the availability** and **supply of water resources** seems to be one of the major adaptive measures that will be needed in Seyhan River Basin. Another adaptive strategy, of course, is a **shift in electricity production from traditional energy sources to renewable** ones.

Major barriers to overcome for improving the infrastructural management can be categorised under three groups namely, **financial**, **legal** and **educational barriers**.

Interpretation and Limitations of the Analysis

The results presented by the CLD (Figure 1) and summarised above, provided an analysis of what participants focused on during the workshop, and which variables were significant in their discussions. In summary, the analysis of thematic groups CLDs suggests that;

(i) consequences of water availability and quality in general, more specifically in agricultural sector;
(ii) socio-economic implications of climate change
(iii) natural ecosystems and assets; iv)
(iv) direct (extreme heat, flood disaster) and indirect (water quality, food security) impacts of climate change on public health;
(v) climate induced natural disaster (i.e. drought and flood) management;

(vi) extreme heat and forest fires; and
(vii) sea-level rise and coastal hazards;

are the seven important issues discussed by all of the thematic groups during the workshop.

Most important limitation of the systems approach workshop was that the thematic groups could not fully complete their CLDs mainly because of the time restrictions. This prevented the participants to explore some more feasible adaptation strategies/measures in detail. Equally important, the participants did not have the chance to identify thoroughly and explore adequately the barriers and opportunities to manage priority adaptation strategies/measures even though this was outside the scope of the workshop.

CONCLUSIONS AND RECOMMENDATIONS

Workshop in general

Seyhan River Basin, a region that is already stressed by intensive land use, will become highly vulnerable to climate change if no appropriate adaptation strategies are developed.

Construction of CLDs during the systems approach workshop allowed the participants to have interactive discussions and helped them to identify priority climate issues and appropriate adaptation measures/strategies.

During the workshop, it became clear that climate change is likely to impact on a range of natural, social and economic issues even though there is still uncertainty over the extent of each of the potential impacts. This issue requires more impact and vulnerability studies in the region.

Throughout the workshop, it also became clear that appropriate measures/strategies are needed to adapt to changing climate and its impacts in the region. Much of the work done during the workshop identified such impacts and adaptation measures/strategies.

Priority issues

On the basis of the analysis of the workshop results, it would be safe to conclude that climate change related **water issues** and their implications for Seyhan River Basin constitute top priority in Seyhan River Basin. Water issues in the basin are all interlinked and it makes sense to address them as an **integrated water management** problem/issue. In this respect, Community-Based Adaptation Grants Programme should consider financial support of pilot projects that can provide necessary adaptive measures with an integrated water management perspective. Such project may consider;

- **Ground** and **surface water availability** and **supply** (to maintain agricultural productivity, food security, natural ecosystems and the goods and services they provide)
- **Agricultural, residential** and **industrial use of water** (efficient use of water)

- **Drought** and **flooding management** (improving preparedness for increased frequency of droughts and floods)
- **Capacity building among the regional stakeholders** (i.e. general public, public and governmental institutions, private sector, NGOs etc.) in terms of climate change impacts and adaptation measures.

Further research

Even though, there was an effort to identify some of the barriers during the implementation of adaptive measures/strategies, much of the potential barriers and their region specific root causes (e.g. due to weak local stakeholder commitment, miscommunication between local, regional and national governments etc.), and/or possible opportunities (e.g. public-private partnerships) were not discussed and identified thoroughly. In that sense, there is still quite a big uncertainty over what kind of barriers and/or opportunities exist in terms of managing adaptive measures. Who, for instance, will be in charge of managing the impacts and adaptation measures? Which organisations/units will be involved in the adaptation work? Is current regional planning policies take climate change into account? Is there a need for legal rearrangements to identify/clarify each local/regional responsibilities in relation to climate change? Do the local/regional organisations/departments have enough resources and capacity to adequately respond to climate change?

Successful implementation of proposed adaptation measures/strategies through pilot projects require answers to above questions. Therefore, a second leg of similar systems approach workshop in a participatory manner will be useful to properly identify these barriers and opportunities, and to further outline the key actions needed to improve regional adaptive capacity for managing climate change vulnerabilities in the Seyhan River Basin. In this respect, such a workshop will certainly have a positive effect on the success rate of the pilot projects.

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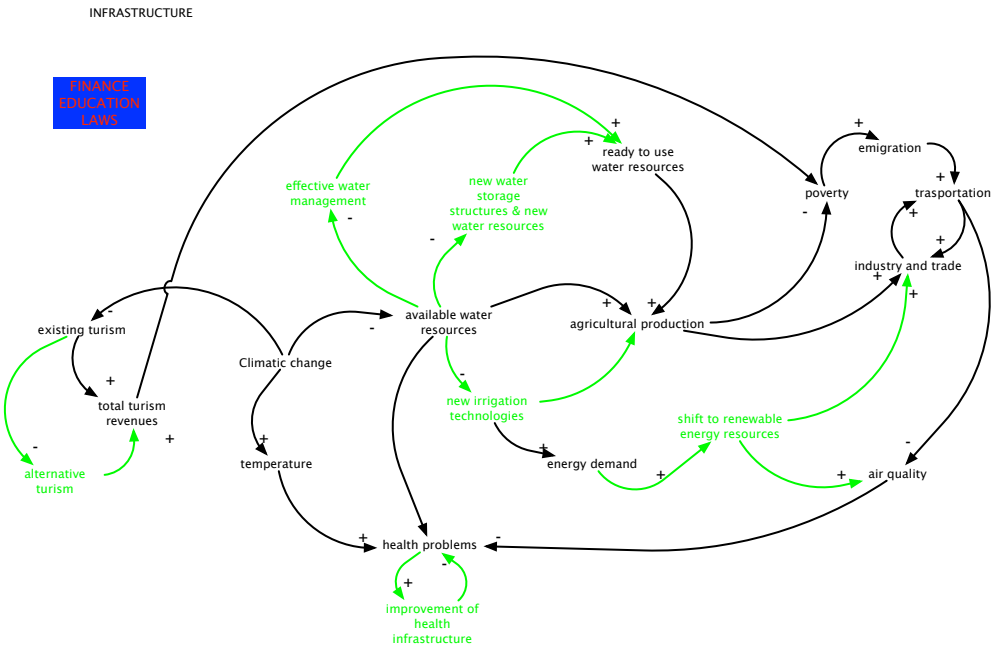
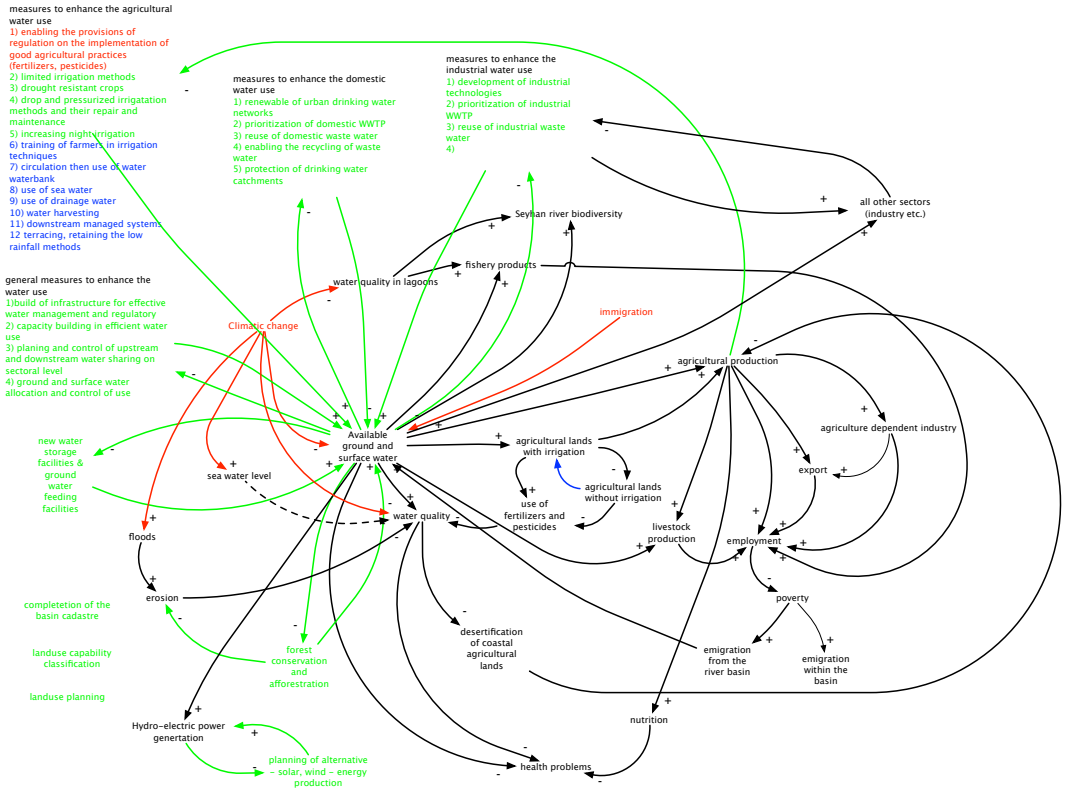
APPENDICES



CLD – Infrastructure thematic group



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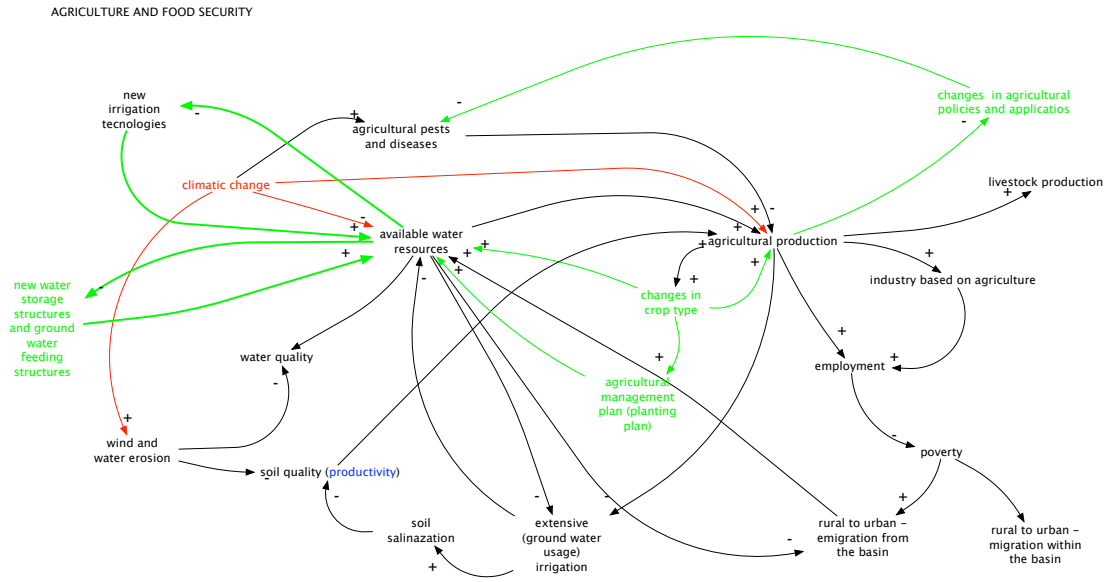

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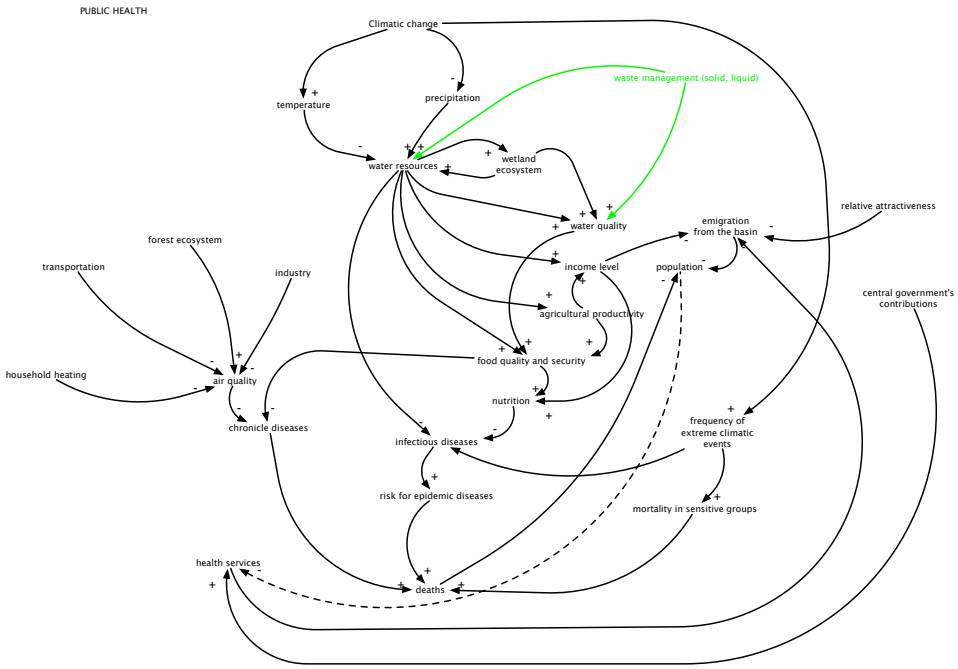

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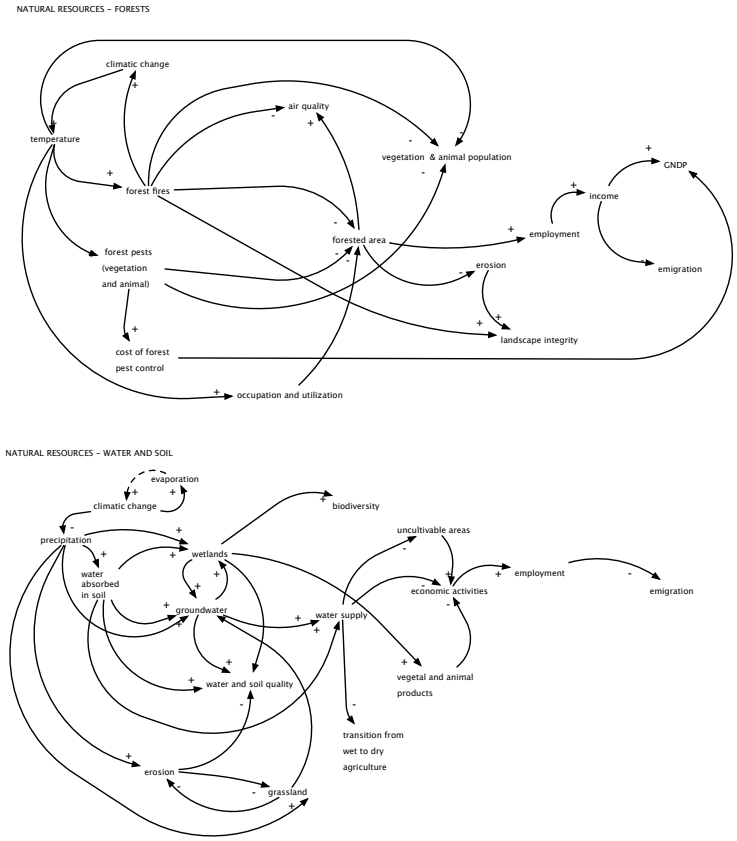
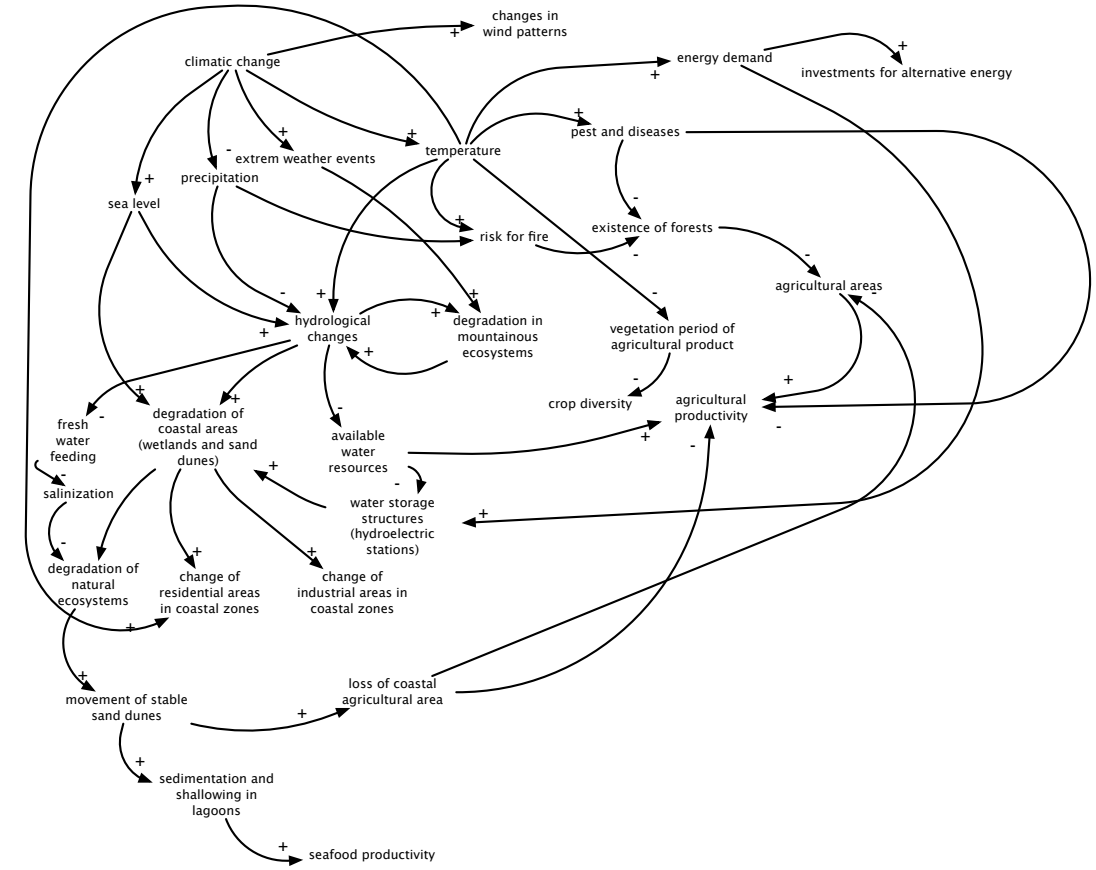
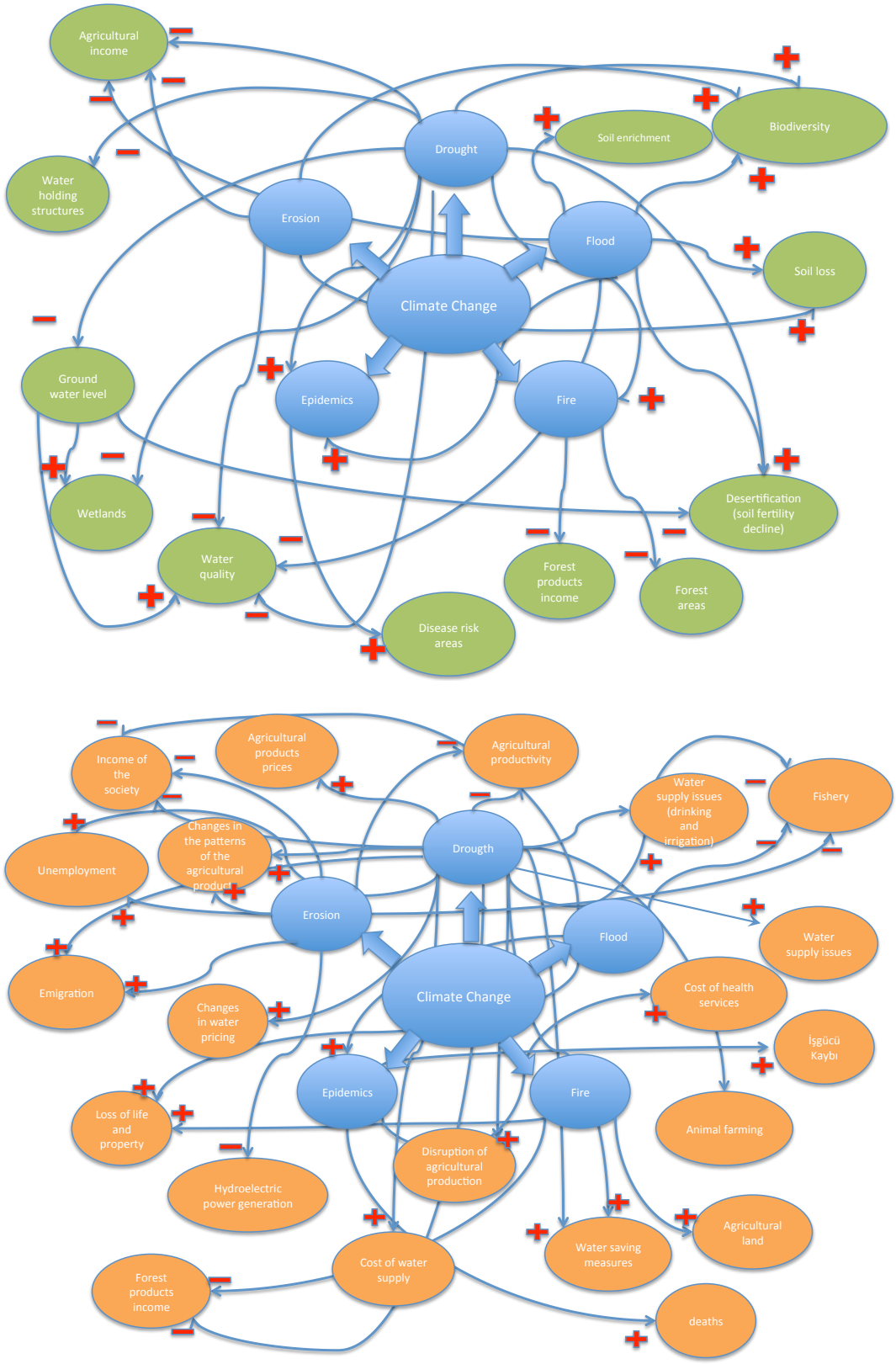


CLD – Natural Resoruces thematic group



CLD – Management of Catchment and Coastal Areas thematic group



CLD – Natural Disaster management thematic group