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Visions for the Future of Water in Seyhan Basin, Turkey: A Backcasting Application

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Abstract: This paper reports backcasting results on the future of water in the Seyhan Basin, Turkey. The participative backcasting methodology uses prior information obtained from stakeholders about the present, future and estimated states of water to optimize time use during the implementation. The study involved a broad range of stakeholders spanning from central decision makers to farmers. Reliable scenarios exploiting all kinds of information sources are crucial in developing dependable and feasible policy options to tackle the challenges residing in water management issues. Perception of the current water system and a structured view of the future in the Seyhan Basin have been determined. The desirable goal has been set as reaching sustainable irrigation by 2030. Necessary actions to reach the desired objective were grouped into four categories, namely policy, infrastructure, legal issues and extended education. After determining specific activities in each category, the relationships and timing of the activities are set and potential obstacles are identified. The findings suggest that the participation of non-governmental organizations (NGOs) with high human capital to policy, legal and infrastructural actions is crucial. Use of water saving technologies, such as pressurized and prepaid irrigation systems, dominate the scenario. NGOs related to irrigation are expected to play a key role in finding funds that are necessary for the infrastructural investments. Support for capacity building in irrigation related NGOs will be vital in reaching the objective. Lastly, subsidies on pressurized irrigation systems will also be inevitable.

Keywords: Climate change; participatory backcasting; Seyhan Basin; water management.

1. INTRODUCTION

Sustainable management of water resources has been an important issue under the pressure of increasing demand for irrigation water in the short run and climate change in the long run. Reliable scenarios exploiting all kinds of information sources are crucial in developing dependable policy options to tackle the challenges residing in water management issues.

The aim of this study is to identify the stakeholders' perception of the current water system and form a structured view of the future in the Seyhan Basin through backcasting. The emphasis is on the policy options that are needed to reach future desired objective.

Backcasting starts with the definition of a desired objective. The aim is to backcast from the goal to the present by identifying the strategic actions. The constructed scenarios include the relationships and timing of the actions. Backward-looking as opposed to forecasting started with energy sector studies in the late 1970s [Lovins, 1976]. The approach has been preferred due to its capability to break the trends rather than respond to trends as it is generally the case in forecasting. Robinson [1988] was the first to address conceptual and methodological issues of backcasting. Quist and Vergragt [2006] provide not only a short overview of methodological development and major applications, but also enlarge the methodological framework to a broad range of stakeholders from different societal groups. The use of fuzzy cognitive maps as a framework to stimulate system thinking during backcasting application is suggested by van Vliet et al. [2010].

Backcasting methodology was new for all participants with diverse backgrounds and the time allocated for the implementation of the methodology was limited to one day. It was necessary to implement a modified backcasting methodology in order to optimize time use and to obtain the proper conceptual map through the backcasting application.

The starting point for the backcasting exercise is the findings of an earlier participatory process conducted with the same participants to obtain fuzzy cognitive maps (FCMs) on the present, desired and estimated states of water in Seyhan Basin [Cakmak et al., 2010].

The rest of the paper is organized as follows. Brief background preparations and framework of the analysis is in the following section. Discussion of the applied method emphasising the modifications in the classical backcasting implementation is in the third section. Section 4 presents the final scenario the last section is reserved for concluding remarks.

2. BACKGROUND AND FRAMEWORK OF THE ANALYSIS

This study is part of the EC FP6 SCENES project. The project is a multi-national attempt at pan-European level, to develop and analyse a set of comprehensive scenarios for the future of European freshwater resources [Kamari et al., 2008]. SCENES adopts an iterative approach such that macro scenarios developed in pan-European level and micro scenarios developed in selected pilot areas provide feedbacks to each other in order to obtain enriched comprehensive scenarios. Seyhan basin is among 9 pilot areas[1] of SCENES which are selected to represent a broad range of climatic, hydrological, economic and political spectrum.

Seyhan basin is located in the eastern Mediterranean. The area of the basin is of 20,450 km^2. The basin contains the fifth largest city of Turkey. The basin's urbanisation rate and population growth are slightly higher than Turkey's averages. Seyhan River drains a fertile plain, Çukurova, and has an average water flow of 8.01 km^3 [DSI, 2010]. Irrigated area in the basin reaches about 300 thousand hectares which is around half of total cultivated area in the region [DSI, 2006; TurkStat, 2010]. All irrigation schemes are managed by Water User Associations. Agriculture is an important activity in the basin. The basin produces about 6 percent of national total with only 3 percent share in total cultivated area. [TurkStat, 2010]. Rapidly growing population and high dependence of agricultural production on irrigation water due to the climate conditions increase the sensitivity of public and private stakeholders to the water issues.

The developed scenarios at the Seyhan Basin level are expected to provide feedbacks for the macro scenarios at the European levels that are based on GEO-4 Scenarios and further developed in by a panel of experts and policy makers from all around the Europe. The storylines at the pan-European level [SCENES, 2009] are i) **Security First:** World becomes politically and economically unstable due to energy, financial and climatic crises. Extensive measures are implemented by all governments to protect the national economies. Water conflicts emerge within Europe and throughout the globe. ii) **Economy First:** Globalization and liberalization increase world trade. Environmental standards are dictated by multinational companies. Many environmental problems arise and stress on water resources significantly increases. Misuse of water resources hampers economic growth and food security issues start to emerge. iii) **Policy First**: Governments throughout the globe evolve into an increasingly integrated structure. However as the level of integration increases the policies become more and more ineffective. EU cannot enforce Water

[1] Other pilot regions are Lower Don Basin in Russia, Crimea in Ukraine, Narew Basin in Poland, Lake Peipsi Basin in Estonia, Upper Tisza Basin of the Danube River in Hungary, Danube Delta in Romania, Guadiana Basin in Spain and Candelaro Basin in Italy.

Framework Directive. Environmental issues suddenly become urgent. iv) **Sustainability First:** Local initiatives lead the transition from globalization to environmental sustainability. The transition is kicked off by a set of events such as economic and environmental problems whose combined effects forces all governments to change their focus from profits and employment to environmental sustainability.

With this background, careful selection of stakeholders was necessary to obtain a scenario that will both help the domestic policy makers and provide feedbacks to the pan-European scenario building activities. The participants belonged to diverse societal groups. Representatives from central and local public institutions related to water and agriculture, environmental and farmers' NGOs, irrigation associations and local university participated in the backcasting process.

The stakeholders were first asked to select the most plausible scenario at the pan-European level. "Sustainability First" scenario was selected as the reference scenario by the stakeholders.

The second task before the start of the backcasting exercise was the identification of the ultimate objective to be reached by 2030. We used the results of an earlier participatory process that was conducted with the same participants to obtain fuzzy cognitive maps (FCMs) on the present, desired and estimated states of water in Seyhan Basin [Cakmak et al., 2010]. Accordingly, stakeholders had identified water demand and use, saving water, impact of climate change and sustainable water management as the major issues. Based on the consensus reached on the high priority issues, the stakeholders were asked to identify the ultimate objective to be reached by 2030. At first, the stakeholders had a tendency to select rather "large" objective such as "sustainability". Eventually, "realization of sustainable irrigation" was determined as the final objective.

3. METHODOLOGY AND FINDINGS

The backcasting methodology used in this study involves sequential use of participative approaches aiming to mitigate diversities and arriving at consensus during the implementation. The applied methodology is a multilayer process where the outputs of one or more phase provide inputs to the other phase (Figure 1). The process consists of the following steps:

i. Defining the realm of the backcasting scene: Using the outputs of the previous workshop where FCMs were constructed [Cakmak et al., 2009 and 2010], in conjunction with the pan-European scenarios, the process depicted in Figure 1 was set.

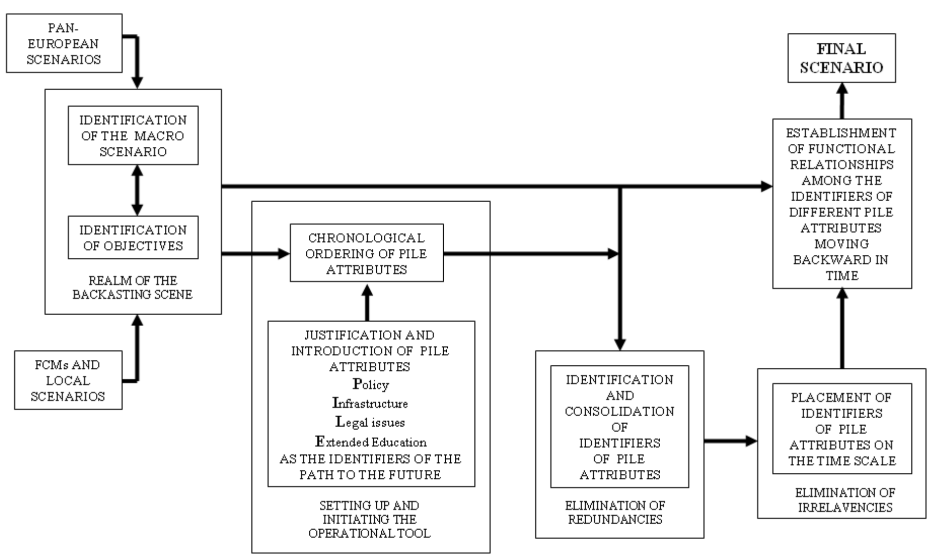

Figure 1. Flow diagram of the backcasting process

ii. Introduction of the PILE (Policy, Infrastructure, Legal, Extended education) elements: The PILE elements are defined using an approach akin to STEEP-L (Social, Technologic, Economic, Ecologic, Policy - Legal) analysis which is used to structure and explore the external environment. PILE elements that constitute the attributes describing the path to the future are defined as follows: **Policy:** Central government and local public authorities are the main actors in water related issues. This group of activities collects all policy actions related to agricultural subsidy, environment, health, water and migration; **Infrastructure:** Problems related to irrigation canals or dams turn out to be challenging in Seyhan Basin. The loss of water due to evapo-transpiration and lack of appropriate reservoirs are the most important problems. Maintenance and renovation are also included in this group; **Legal:** State is the sole owner of water resources in Turkey. Thus legal arrangements are necessary to make radical changes in water policy. Establishment of new institutions and incentive systems needs legislative actions; **Extended Education:** Transformation of the water management system requires an active participation of the water users, especially the farmers and upgrading the capacity of technical staff.

iii. The chronological ordering of the PILE elements by the participants: Chronological ordering of the PILE elements is achieved with the help of relationship dependency matrix by the stakeholders. The following chronological order was obtained: **P**olicies, **L**egal issues, **E**xtended education and finally **I**nfrastructure (PLEI) implying a path in which policies lead to legislative actions, determining necessary training and finally, the construction of the required infrastructure was agreed upon. Consistent with this general storyline, the PILE elements are then placed on the timeline such that the virtual median activity in each PILE element coincided with 2014 for Policy, 2018 for Legal issues, 2022 for Extended education, and 2026 for Investment.

iv. Identification of the activities, the identifiers of a specific PILE element: The participants are asked to define specific activities for each PILE element without considering any time span, but by keeping the functional relationships in mind. The process is carried out by group discussions, with the contribution of all the participants and this alleviated the time to reach a consensus. Each group suggested 3 activities under each PILE element in reverse chronological order, that is in the order of IELP. Redundancies of the suggested activities are eliminated in a forum setting. The final set of actions obtained is presented in Table 1.The activities in policy group, P1-P6, aim to create incentives for the use of water saving technologies. Price mechanism is the most important policy tool. Special emphasis is put on the role of NGOs. Infrastructural activities, I1-I7, consist of pressurized systems, drip irrigation and pre-paid systems. Investments for efficient use of water in agriculture and monitoring water use are also prioritized. Legal activities, L1-L8 fully support the policy actions. Educational activities, E1-E7 focus on extention services and training of water users and authorities at all levels to reduce water use.

v. Placement of the activities on the timescale by moving backward in time: Assignment of the duration and completion times of activities were carried out by moving backward in time. Temporal disagreements were used to identify and to eliminate irrelevant activities with further discussion in groups and forum setting as described above.

vi. Establishment of the functional relationships among the activities by moving backward in time and identification of obstacles: Once consensus on completion time and duration for each activity was established, the participants were asked to identify the chronological order of preceeding activities that are functionally essential for the realisation of the activity. This yielded the backward functional dependence map. The adjustments, done by the participants, in the completion time and duration of the PILE activities enhanced the consistency of the dependency map.

The conceptual map (CM) thus modified, was subjected to additional fine adjustments to obtain its final form. The total number of identified paths in CM was 78. Paths that form the map were grouped under two categories as complete and incomplete in order to concentrate on the major paths. Complete paths are those which cross through an activity from each one of the groups' activities in the order of PLEI and reach the objective. The CM contains 64 complete paths. The rest of the paths are incomplete, i.e. they end in an activity that does not have a functional relationship with the objective.

Table 1. Consolidated Activities

Policy	
P1	Subsidies to save water
P2	Promote water saving with stakeholder involvement
P3	Capacity building for NGOs in irrigation sector
P4	Higher prices for non-pressurized water use
P5	Water saving treated as an agricultural support policy
P6	Decrease in the conversion of arable to non-agricultural uses with less migration
Infrastructure	
I1	Higher irrigation efficiency in existing schemes, new schemes are all pressurized
I2	Planned storage capacity completed
I3	Lower water intensive crop pattern achieved
I4	Central pressurized distribution and field level pre-paid systems installed
I5	All pressurized system in Seyhan, heavy use of drip irrigation
I6	Installation of local stations to determine crop water requirements using IT
I7	Single agency for the management of irrigation systems
Legal	
L1	Single agency to manage and monitor water resources
L2	Incentives to develop water saving technologies
L3	Investment subsidy for pressurized systems and penalize excessive use
L4	Empower irrigation unions in managing water.
L5	Crop pattern planning suitable for regional climate and geography
L6	Organized agricultural society
L7	Distinctive water management at the national and regional levels
L8	Effective stakeholder involvement in shaping legislation
Educational	
E1	Intensive training of the farmers on saving water
E2	Raise awareness in the whole society on climate change and saving water
E3	Trained technicians reached the farmers
E4	Training of the technicians
E5	Project development training to finance infrastructural investments
E6	Applied training at the farm level
E7	Joint training of all water managers

4. FINAL SCENARIO

Backcasting supplies rich scenarios with many actions necessary to reach the ultimate objective by providing functional relationships together with their completion time and duration. Before the final conceptual map representing the backcasting exercise is presented, the following points will be explained

i. Based on the responses of the participants, the links listed in Table 2 were identified as being subject to some functional or operational obstacles on any complete path. Their positions and characteristics are summarized in Table 2.

Table 2. Obstacles and Related Links between Activities

Link	Obstacle	Link	Obstacle
P3-L3	Lack of NGOs capacity	**E5-I3**	Insufficient human capacity and funding to finance the investments
P6-L3	Rent seeking behavior	**E4-I4**	
P6-L8	Rent seeking behavior	**E5-I4**	
L1-E5	Conflict in centralization & participatory processes		

Note: For the description of the activities see Table 1.

ii. After the final adjustment mentioned above, the relative position of the means and durations of each PILE group has changed. The mean of the Policy block (P) is pulled towards 2012 from 2014, implying need for immediate action. Policies related to water savings and capacity building for irrigation NGOs (P2, P3 and P5) ended up being crucial to reach the objective. Legal arrangements start as early as 2013, and continue until 2019, implying a shift of the mean of Legal Issues (L) to 2016 from 2018. The completion of legal arrangements takes more time than that of policies, suggesting that implementation of policies takes longer than producing them. Considering the links from policies, investment subsidy for pressurized systems and stakeholder involvement in legislation (L3 and L8) are the most challenging legal activities. The mean of Education block (E) is pulled back to 2020. Work on infrastructure starts on 2016 and ends in 2029, leading to a completion time of 13 years. This is also consistent with the general storyline, as many of the infrastructure elements are the culmination of a chain of activities starting from policies. Investment on pressurized and pre-paid systems (I1 and I4) are the activities that pose a threat to the achievement of the final objective, as they depend on many other activities including the ones with major obstacles.

The final conceptual map is presented in Figure 2. In order to concentrate on the complete paths, incomplete paths are removed from the map. Policies targeted to increase the capacity of water related NGOs are crucial with the highest number of links. That is followed by treatment of water saving within the agricultural subsidies.

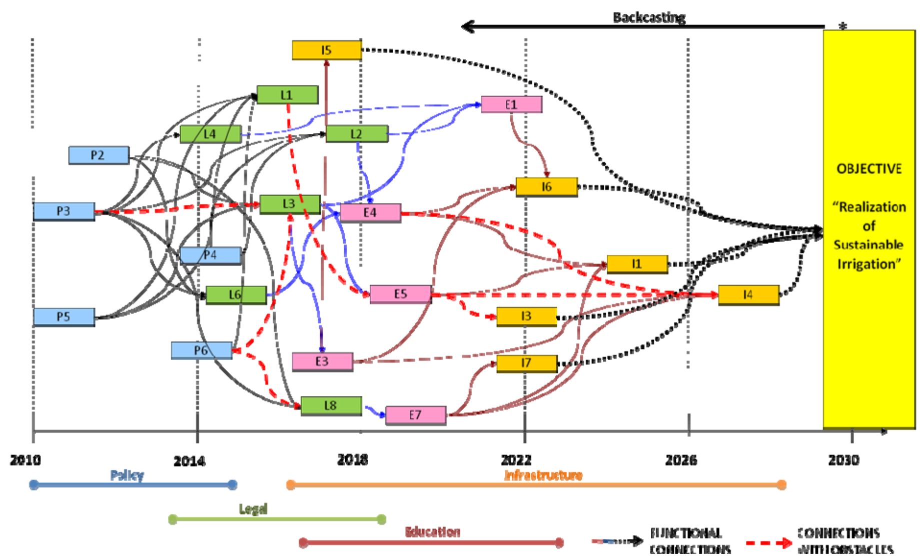

Figure 2. Conceptual Map

Note: For the description of the activities see Table 1.

Legislation of subsidies in pressurized systems and penalizing excessive water use is the most crucial legal activity that will take place around 2015. Almost 50 percent of the paths toward objective pass through this legislation which will be initiated by policies to spread use of water saving techniques and subsidizing these techniques. However, conversion of fertile land to non-agricultural use, such as housing is a major obstacle that will challenge such policies and legislations. A significant rent seeking activity may prevent these legislation activities. Legislation to support research and development (R&D) in water saving technologies is the also an important activity that is expected to take place around 2018. This legislation will depend highly on capacitated NGOs, changing water prices in favour of using water saving systems and introduction of water saving subsidies. Increasing the transfer of R&D activities to the field level will enhance the capability of farmers and technicians in using new technologies. Taking feedback from the people in the field is also crucial and is expected to be completed by 2018. Policies targeted to develop NGOs, enrolling the stakeholders in policy making and preventing the conversion of agricultural lands to non-agricultural uses will be main drivers of this process. As a result, public awareness in climate change will be raised, links between water authorities, universities and relevant organizations will become rigorous and continuous training of water authorities will be possible.

Educational activities are at the core of the scenario. They will start in 2016 and last until 2023. All people involved in irrigation and agriculture are subject of training activities. Training topics are determined as pressurized systems, prepaid distribution and calculation of crop water requirements. Availability and use of international and national funding opportunities arise also as a training activity. Legislation on monitoring water use and investments subsidies on water saving systems necessitate such training activities. Continuous training of water related staff at all levels is crucial. Transformation of all irrigation systems to water saving technologies and shifting to less water demanding crops depends highly on the effectiveness of these training activities. Lack of financial resources and human capital may seriously hinder the development of the necessary infrastructure. Lastly training of farmers on water saving technologies is also pivotal in establishing a sustainable water management. Farmers should be able to use the information supplied by monitoring stations on crop water requirements.

Infrastructure that is essential in achieving sustainable irrigation management is identified as the extension water saving technologies to all irrigation systems, instalment of local monitoring stations, pressurized and pre-paid systems. Among those, instalment of pressurized and prepaid system will be the most important. This will require a heavy training activity for the technicians who will install these systems and for the technicians who will train farmers. Lack of financial resources and human capital is an important obstacle on the way. Hence training of water authorities and increasing the links between academia and practical people will also be crucial. Further, taking feedback from the stakeholders in the region is also critical for the instalment of pressurized system since central authorities may not appreciate the importance of these systems. Local satiations that will calculate the crop water requirements from the climatic data are also important. Training of technicians about usage and instalment of these stations will be crucial for this infrastructure. Further farmers should be capable to use the available information in making decisions.

For the complete paths, capacity building in NGOs, mainly water user associations, plays a key role by being the starting activity for 23 paths. NGOs are considered to be crucial for most of the legislation activities, contributing to the master plans on agricultural land use. In fact, support for capacity building in NGOs is considered as urgent, and it starts in 2010 and ends in a few years. Only then these NGOs will be available to take active part in legislative processes. On the other hand, legislation of subsidizing investments in closed and pressurized systems may be opposed by water user associations due to possible rent seeking behaviour.

5. CONCLUDING REMARKS

Better management of water resources has gained importance due to increasing pressure on available water resources brought by climate change and increasing demand for water. Although mitigation measures differ according to the geographical, social, political and legal context, at least the search for solutions have common aspects. Developing reliable scenarios is such a tool and enrolment of local stakeholders is decisive in increasing the reliability of any scenario building activity. Backcasting methodology is a powerful tool to develop such scenarios but in most cases it requires a substantial amount of time to implement and/or the researcher is forced to narrow down the context of the problem at hand.

In this paper we suggested a methodology to increase the efficiency of participative backcasting, especially when time is scarce and participants are coming from diverse backgrounds. In order to overcome these difficulties, we put forward a framework, namely PILE, that is easy to understand and implement, but also comprehensive enough to identify all potential activities. PILE framework has helped to organize both the minds of the participants and the steps that will be taken to draw the conceptual map by allowing prioritization of the action groupings. In that way, revealing the functional relationships and obstacles is relatively easy and straightforward.

We also presented the results of the implementation of this method to develop a scenario about the future of water for one desired outcome in Seyhan Basin, Turkey. Obtained conceptual map suggests that to attain the realization of sustainable irrigation water use, policy development activities should take precedence. Then legislation activities are needed to implement these policies followed by extended education. The installation of necessary infrastructure is the last activity set to attain the objective. The most important policy activity will be developing policies that will support human capacity building in irrigation NGOs. Legislation of subsidies on water saving technologies will be the most important legal activity that will follow. Thirdly, training of NGOs and water authorities as well as technical personnel will be required prior to infrastructural investments. Lastly, the instalment of pressurized systems and prepaid systems will be the most important investments to reach a sustainable irrigation management. Accordingly, participants believe that NGOs will be the key actors in reaching the sustainable irrigation. They will play a major role in legislation processes by interacting with policy makers.

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