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CHAPTER IV

MEDITERRANEAN SOILS USE AND MANAGEMENT

DEVELOPING A SUSTAINABLE LAND MANAGEMENT RESEARCH STRATEGY FOR THE SOUTHEAST ANATOLIAN IRRIGATION PROJECT

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Introduction

The Government of Turkey has embarked on an ambitious project to develop the southeastern part of the country addressing the important issue of food security. An area of 74,000 km^2 presents a fantastic laboratory and a challenge to ensure sustainability of agriculture. In general, the climate of this area is of the Mediterranean type with hot and dry summers and mild and humid winters (Figure 1). The Soil Moisture Regime according to Soil Taxonomy (Soil Survey Staff, 1998) is Xeric and the Soil Temperature Regime is Thermic.

A great variety of soils are present in the area. They include Inceptisols on the hill slopes in association with shallow Entisols and rock outcrops, mixed with friable, reddish Alfisols derived from basic rocks and limestone, and interspersed with sticky, Vertisols. Mollisols are also present but probably were of wider extent in the past. Erosion has decapitated the mollic epipedon and also reduced the effective thickness of the soils. The water holding capacity of the Alfisols and Mollisols is about 50 to 100 mm per meter while the Vertisols have a higher capacity of about 150 mm per meter of soil. Wind blown sand may cap some of the soils while dunes of several meters are also present.

As agriculture is dependent on water, the kind of soils is crucial. A detailed soil map was initiated in 1985. This was complimented with Landsat-3 MSS data, the latter being also used to monitor grain production (Dinç and Kapur, 1991). In the last three decades, a large number of agronomic experiments were laid out for several crops. Most were designed to determine crop performance and/or the response to management. All these research results provided the needed databases and an experience base that would assist in the eventual establishment of the GAP programme. However, as indicated previously, the focus was production and not sustainability.

Developing new paradigms, designing strategies for the new challenges, and implementing long-term research activities in the area of sustainable land management (SLM) are the current needs that Turkey face. The GAP project provides a unique opportunity to implement such a programme. The purpose of this paper is to evaluate the conditions and suggest some research areas for the implementation via developing SLM strategy within a contextual approach.

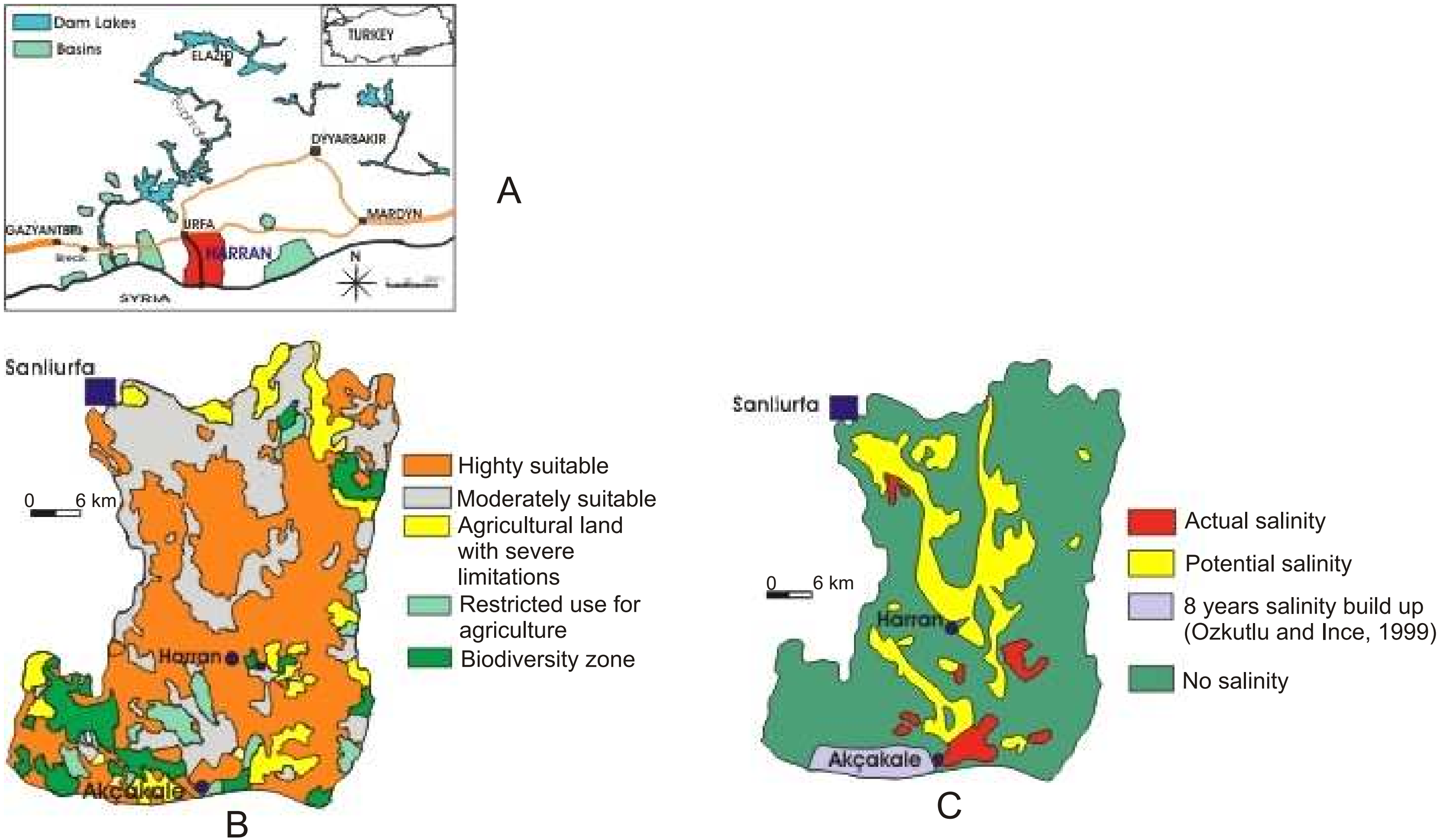

Figure 1. The Southeast Anatolian (GAP) Irrigation Project Basin (A). Land suitability (Senol et al. 1991) (B). Actual and potential salinity (Dinç and Kapur 1991) © in the Harran Plain

The Basis for SLM: Description of the elements of a contextual approach. The Euphrates and Tigris Basin Context

The major part of the Euphrates and Tigris (ET) basin is suffering degradation of the ecosystem by intense cultivation and irrigation throughout its long-term history. Despite the combat against salinity, this process it is dramatically spreading, since the times of the Sumerians.

Erosion and siltation are aggravating the situation (Lowdermilk, 1994), especially in Iraq and Syria. Iraq has been unique in the magnitude of historically built-up salinity with 8.5 million ha saline land which makes up to 64% of the total arable land surface or 90% of the land of the southern part of the country (Kapur and Akça, 2002).

Southeast Anatolia is located on the northern part of the basin and is the birthplace of the two historical rivers of Euphrates and Tigris. Both these rivers are made possible for the human settlements and beginning of urbanisation, together with widespread present-day agriculture at sub-basins between grabens and alluvial deposits.

Despite the early human occupation of the area dating back to the Neolithic period, the ecological preference towards the development of animal husbandry (even though erosion by overgrazing was induced), has on the contrary prevented development of irrigated agriculture, thus salinisation.

Therefore, a sustainable water and land management (SWLM) plan for the basin should be urgently developed in order to sustain the characteristics of the present climate. In fact, the climate on average has been showing to have been similar since the Iron-age (1,200-580 BC), except the dry cycle in 2,350 BC.

Unlike the vigorous fluctuations of the Pleistocene, the shorter and longer climatic deviations occurring during the 5th millennium BC and later in the Holocene has been rather similar (Oxford Encyclopaedia, 1997). The minor fluctuations of the Holocene have been responsible for the development of the unique plant species and the natural vegetation of the northern part of the ET basin, included in Syria and Anatolia (De Pauw *et al.,* 2002).

The ET area has historically been dominated by a system characterised by grazing small ruminants and growing rain-fed grain crops on valley bottoms. When a source of water was available, (tube-wells or aquifers) local irrigated crops were developed and a larger variety of crops (cotton, chickpeas, lentils, and tree-crops) were grown.

Dramatic increases in yield performance on irrigation are evident. However, the stability of the system is uncertain. After the harvest of grains, the straw is removed as fodder for animals, and small ruminants graze the remaining stubble. A net export of plant nutrients takes place from the fields, as the amount of fertilisers used is minimal. With establishment of irrigation facilities, and accompanying available subsidies, there is excessive use of agro-chemicals to maintain high production. The effects of this type of management are yet to be established and estimated.

The Land/Ecosystem Degradation Context

Land degradation and intensive use of agricultural chemicals is recognised as the major non-point source of water pollution (CAST, 1992). Soil erosion results not only in the movement of sediments, but is also associated with dissolved phosphate (transported with sediments), nitrates, and pesticides from croplands to water-bodies. Eutrophication occurs in surface waters.

The costs of on-site and off-site damages resulting from land degradation are not known for most countries. Informed opinion suspects that the ratio between the two is on the order of 1:10 to 1:100. On-site damages are often related to crop productivity losses and a compressive study of this for the United States was made by Crosson and Stout (1983).

Although, they acknowledge lack of data and knowledge about relationships between soil characteristics, productivity, and erosion, they note that crop productivity losses are in general small (2 to 8%) and that yield declines are generally not sufficient to judge the importance of the losses to society. Impacts on productivity, however, are only part of the question. In Ethiopia, a detailed assessment by Hurni (1993) indicates that soil erosion (estimated to be 1.5 billion tons annually from the highlands) results in about 1 to 2% loss in productivity, which translates to about 15 million dollars annually.

The nutrients that are lost, however, are estimated to have a value of about one billion dollars if the soil is to be replenished. The annual sediment load in the Euphrates was estimated to be about 110 million tons (Atalay, 1986), whereas it is much less today (10.5 million tons) due to the construction of recent dams (Bal, 1998). If the situation becomes extreme, as in countries where steeply sloped lands are extensively used, erosion will reduce the soil depth to less than 10 cm and will be abandoned and beyond rehabilitation.

Another major concern is the less obvious impact of land degradation arising from the conversion of natural habitats to agriculture and other uses. This is now recognised as a major contributor to the loss of genetic stock and diversity. At current levels of conversion (with accompanying accentuated negative changes resulting from degradation), it is estimated that 25 percent of the world's plant species will disappear in the next 50 years and these are permanent losses as ecosystems seldom revert to their original composition (WRC, 1992).

Water Availability and Distribution Context

Irrigation system efficiency has always been questioned in many countries of the world. In Turkey, the history of irrigation projects indicate that quality/quantity success depends, in addition to the engineering structures, on management of the land, water, and human problems in the affected area. Because of political pressures, many projects have been implemented even before their main distribution and drainage networks were completed.

The long-term consequences have yet to be studied. Water use efficiency appears to be a secondary concern to irrigation engineers. Ad hoc studies have shown water losses of up to 50% in some areas. Inappropriate or inadequate land leveling further reduces the efficiency of water use.

Much of the inadequacy in irrigation systems leads to secondary salinisation. In some older projects (Çumra, Menemen, and Seyhan), detrimental changes have occurred in soils as a result of poor drainage facilities. Resulting salinisation has discouraged farmers from capitalising on the irrigation and instead revert to dry-land practices. In the Çumra project, it is estimated that 42% of the land is still under fallow (Tekinel, 1994). This cannot be corrected unless there is more social and political accountability. Though not directly land related, this is also part of sustainable land management.

The problem of insufficient amount of water entering a delta was mentioned earlier. With new irrigation projects coming on line, and with ever-increasing hydroelectric projects, the quantity of fresh water entering the sea will be less. This will affect the salinity of the water on the coastal platforms and have great impact on the aquatic life. Further, irrigation water remains largely within the systems (accentuated by poor drainage facilities), evaporates during the hot season, and results in salinisation of the soils. These processes are termed "endoreisation" (Samra & Eswaran, 1998), which if not monitored, have devastating ecological consequences.

A Framework for identifying SLM indicators: Problems of Soil and Land Degradation

The concept of sustainability incorporates a time frame of decades and SLM ensures the optimal functioning of the system over this frame. The most important components of the SLM programme are the indicators that are used to monitor the progress of the system.

A suite of indicators that monitor the stresses (pressure) experienced by the system, the state of the system, and the responses to the stresses, are needed. The DPSIR (**D**riving Forces, **P**ressures, **S**tate, **I**mpacts, and **R**esponses) framework approach is developed to meet this need for soil and land degradation developed by the EEA (1999). The methodology is developed for describing, monitoring and controlling environmental problems based on the use of indicators, which are directly or indirectly ecological, technical, social or cultural.

This is a tool which is useful to evaluate progress and system behaviour by regularly monitoring and analysis, which finally leads politicians and decision-makers to respond to a situation, thus creating the suitable means for all persons concerned at grass root level (Verheye, 1999; Blum, 2001).

Preserving the heritage

The GAP area has known civilisation for more than 5,000 years. Evidence of this is in the soil as burial mounds, *höyüks* or tells, and archaeological fragments. Meeting current food security needs could be accomplished while preserving and protecting the history of the mankind. In developing the area for irrigation, continuos vigilance is necessary to protect all antiquities.

Economic Viability and Ownership of the Concept

The economic viability of the farming community is the driver of the sustainability paradigm in the project area. In its absence, the farmers' preoccupation with survival prevents them from contributing to environmental concerns. Appropriate government support, marketing facilities, infrastructure such as road networks, and an efficient extension service assure viability.

Finally, the success of an irrigation enterprise is strongly governed by the socioeconomic milieu. Land tenure is a major issue. Ownership has to be guaranteed to ensure productivity and sustainability of the program. In addition to land ownership, the project must consolidate and allocate land for other uses (including biodiversity considerations).

A related question concerns water rights for the users. This must be determined and agreed from the beginning. Moreover, there must be adequate support services to ensure help when needed and to provide the technical and marketing facilities crucial for the stability of the area

The Harran Project: A case Study

Thirteen project areas are defined for the GAP programme and the Harran Plain is the first area to be developed. The area including 225,000 ha is bounded on the south by Syria and the Tektek, Fatik, and Urfa Mountains, in the east, west, and north respectively. Details of the soil and physiographic characteristics of the region are given by Dinç and Kapur (1991).

A semi-detailed soil survey at a scale of 1:25,000 was made for the area in 1991 and a large number of soils were sampled and analysed to support the soil survey programme. The maps were digitised and several kinds of additional information were included in the attribute files.

Using the tools of Geographic Information System (GIS), interpretative maps were prepared such as the one shown in Figure 1, which shows the secondary salinisation that could result from irrigation using soil texture, clay minerals, slopes and actual EC values (Dinç and Kapur, 1991).

This map has been proved to be correct by a monitoring study that determined the high salinity in potentially saline areas (Fig. 1), particularly in the southern part of the Harran Plain. Salinity was introduced via the present open channel irrigation system in spite of the high water quality used (Ozkutlu and Ince, 1999).

Finally, a land suitability map, that delineated the areas suitable for agricultural use ([a]enol *et al.,* 1991) was prepared (Fig. 1). The study was also complemented with socioeconomic surveys and demographic information. The Koruklu Agricultural Research Station of the University of Çukurova is conducting farming systems and irrigation research.

Since completion of the first phase of the project, sustainability has become an issue and a new strategic plan was deemed necessary. Figure 2 shows the proposed activity chart for the project. A Master Plan using the base-line information is being developed that identifies areas for irrigated agriculture, dryland agriculture, grazing, biodiversity zones, and archaeological sites to be preserved intact along with economical viability and possible sites for location of villages. Loss of productive agricultural land from urban growth is plaguing the country, and this is a major long-term sustainability question that needs to be addressed.

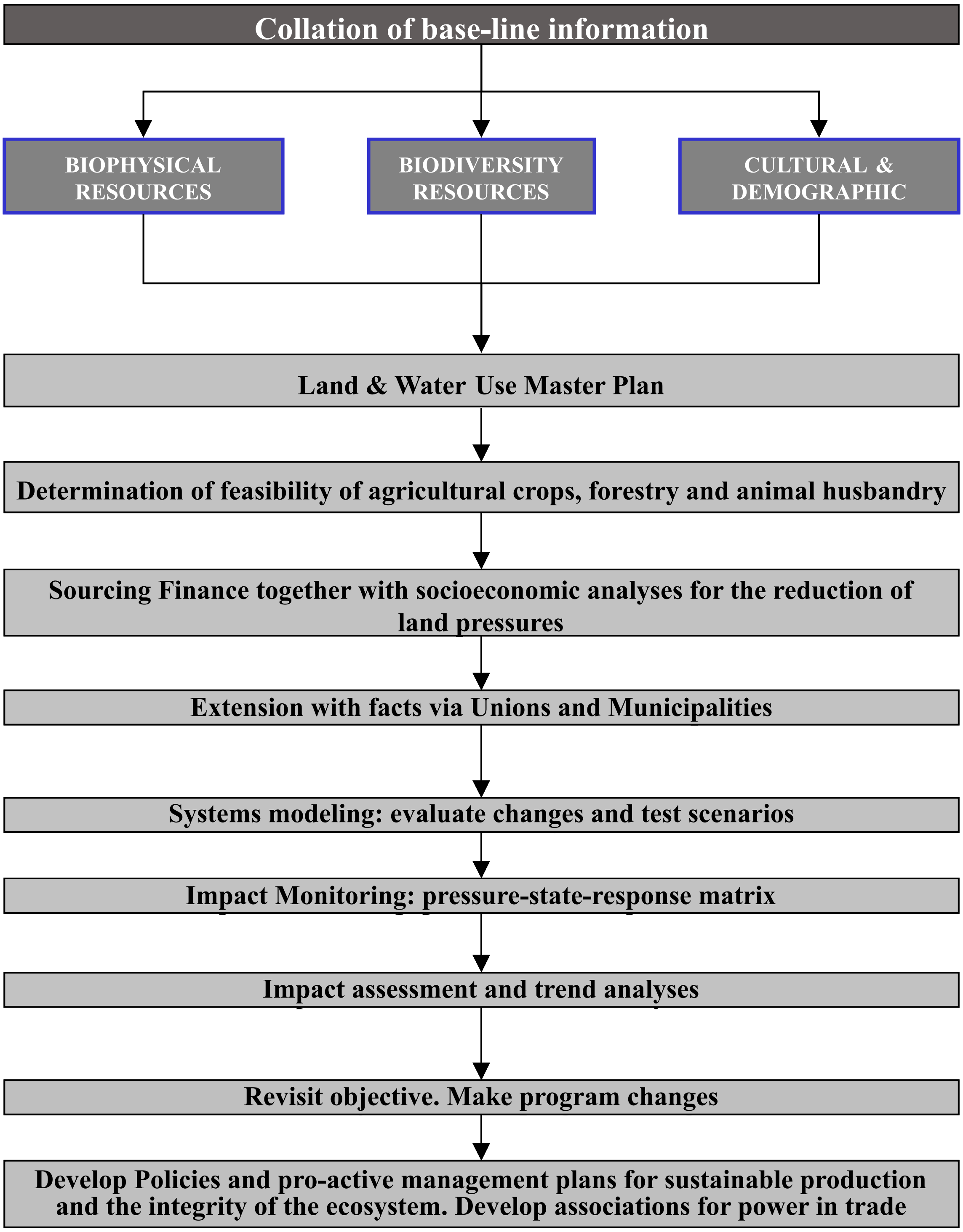

Figure 2. Harran Project area activity chart

Long-term agronomic zones *ie* agro-ecosystem/agro-forestry regions (or zones) for Turkey, which could stand against the misuse of natural resources (Cangir et al. 2000, Dinç et al. 2001) have been established following the previous norms of best soils or most extensive soils. Sites that represent tension zones will also be selected. The latter represent less favourable conditions but actual situations on farmers' fields.

Data of farming and cropping systems are now being used in simulation models, and, as experience in the use of these models increase, they will be used in developing several scenarios. Cumulative experience and data will eventually be used to develop decision-supported systems for farm managers, extension service, and progressive farmers.

Selection of indicators, particularly those that relate to the environment are difficult to define. Discussions are underway to select appropriate ones. International projects, such as the Land Quality indicator Project of the World Bank (Beinroth *et al.* 2001), are working in this area and we will use their recommendations.

Similarly, impact monitoring is also being developed by other international organisations, and their approach will be adapted for our use. Impact assessments will be made every five years. They provide an opportunity to determine the status of the resource conditions and corrective actions that must be taken if there are weaknesses in the system.

Conclusions

SLM calls for the paradigm shift that research must be holistic and systems based. It should include not only agronomic, crop, and livestock based observations, but also monitoring of the linkages of these to the ecosystem and to the socioeconomic conditions of the area. It should show change and specifically monitor how the resource base is maintained or enhanced.

In the final analysis, it should clearly demonstrate that agriculture is environmentally friendly. The farming community must also demonstrate a paradigm shift in the way they participate in the programme.

Plucknett & Winkelmann (1995) stated that farmers would have to confront formidable challenges in learning to manage ever more advanced technologies in ways that will increase the productivity of their resources while protecting the environment. They stress that this will be a daunting task in the developing world. In some of the countries of the Mediterranean region, there are still many obstacles to adopting science-based technologies. Notwithstanding, this must be the goal of not only national decision-makers but also the premise for any research strategy.

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