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Regional sustainable water and energy development projects: A case of Southeastern Anatolia Project (GAP) in Turkey

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ABSTRACT

Southeastern Anatolia Project (GAP) region in Turkey is rich in water for irrigation and hydroelectric power. The Euphrates and Tigris Rivers represent over 28% of the nation's water supply by rivers, and the economically irrigable areas in the region make up 20% of those for the entry country. Turkey has a total gross hydropower potential of 433 GWh/yr, but only 125 GWh/yr of the total hydroelectric potential of Turkey can be economically used. By the construction of new hydropower plants, 36% of the economically usable potential of the country would be tapped. The GAP region has a 22% share of the country's total hydroelectric potential, with plans for 22 dams and 19 hydroelectric power plants. Once completed, 27 billion kWh of electricity will be generated annually.

Contents

1. Introduction

Water resources development around the world has taken many different forms and directions since the dawn of civilization. Humans have long sought ways of capturing, storing, cleaning, and redirecting freshwater resources in efforts to reduce their vulnerability to irregular river flows and unpredictable rainfall. Early agricultural civilizations formed in regions where rainfall and runoff could be easily and reliably tapped. The first irrigation canals permitted farmers to grow crops in drier and drier regions and permitted longer growing seasons. The growth of cities required advances in the sciences of civil engineering and hydrology as water supplies had to be brought from increasingly distant sources. On the other hand, our modern industrial societies routinely and dramatically modify the hydrologic cycle through unprecedented construction of massive engineering projects for flood control, water supply, hydropower, and irrigation [1–4].

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The growth of modern "conventional" irrigation since 1900 has been characterized by large water projects that harnessed rivers through the construction of diversion structures and canal systems. Since 1950, the spread of such technology accelerated through state-sponsored large-scale irrigation and an emphasis on large dams for water storage. Irrigated areas increased from 40 million hectares in 1990 to 100 million hectares by 1950 and to 271 million by 1998. Dams support 30–40% of this area, with the remainder supplied from direct river abstraction, groundwater and traditional water harvesting. Since the 1970s, the predominant focus has been on providing irrigation to support the green revolution package of hybrid seeds, chemical fertilizers and pesticides. Conditions for higher growth were created in such areas through subsidized infrastructure, agricultural inputs and electricity for pumping [2].

The planet may be largely covered with water, but over 1000 million people were estimated to be without safe drinking water in 1998 and almost 3000 million were without adequate sanitation in developing countries. This situation is not surprisingly, almost half of the world population still suffered from diseases associated with insufficient water at the beginning of the 1990s. In many cases, water resources development frequently requires large investments and longtime horizons which cannot always be easily afforded by poorer countries with scarce financial resources. In addition, high rates of population growth will continue to put severe pressure on the ability of many developing countries to provide water supply and sanitation to their unserved population [2].

Turkey has dynamic economic development and rapid population growth. It also has macro-economic, and especially monetary, instability. The net effect of these factors is that Turkey's energy demand has grown rapidly almost every year and is expected to continue growing, but the investment necessary to cover the growing demand has not been forthcoming at the desired pace. On the other hand, meeting energy demand is of high importance in Turkey. But exploiting the country's large energy efficiency potential is also vital. Air pollution is a significant problem and, as the government's projections show, carbon emissions could rise sharply if current trends continue [5–7].

The GAP will play an important role in the development of Turkey's energy and agriculture sector in the near future. For this reason, it is suitable to examine the general structure of this project and its effects. The GAP project is one of the largest power generating, irrigation, and development projects of its kind in the world, covering 3 million hectare of agricultural land. This is over 10% of the cultivable land in Turkey; the land to be irrigated is more than half of the presently irrigated area in Turkey. The GAP project on the Euphrates and Tigris Rivers encompasses 20 dams and 17 hydroelectric plants. Once completed, 27 billion kWh of electricity will be generated annually, which is 45% of the total economically exploitable hydroelectric potential [8]. In this paper, general structure of the project, the natural resources and the hydro-electrical energy generation potential of the GAP is aimed to be evaluated as well as investigating the physical characteristics of the water source systems of the region in relation to planning-application problems [8–19].

2. Sustainable development

The concept of sustainable development is not new. The general philosophy behind this concept was expounded centuries ago [2]. With the growing concerns over economic decline, population growth, the depletion of natural resources and imbalances in the apparent results of development processes, etc., attempts have been made to interpret these as consequences of the dominant discourse of development. The development process should be able to adapt to changing circumstances, to maintain or to "sustain" through flexibility [3]. Its negative impact over time and space captured the imagination of development practitioners and analysts. On the development scene, the term "sustainable development" thus became a popular catchphrase. Where a part of society is not able to meet the basic needs of life, the desirability of reviewing the whole process of development assumes paramount significance. The search for sustainable development emerged from these concepts and reflects less a consensus about what should be than a rejection [3,6,11].

Sustainability is a rather new concept in international development literature. Here, each country is expected to determine its sustainable development criteria by paying due consideration to its specific circumstances. To conduct relevant assessments in this field, the GAP Administration held a seminar in March 1995 in cooperation with the United Nations Development Program (UNDP). This seminar was attended by all sectors related to the process of development in the GAP region and set the following targets in the context of sustainability based upon the objectives and projections of the Master Plan [7–10]:

- Enhancing investments so as to ensure the maximum possible improvement of economic conditions in the region.
- Bringing education and health services up to national standards.
- Creation of new fields and opportunities for employment.
- Improving the quality of urban life and upgrading urban infrastructure so as to bring about healthier urban environments.
- Completing rural infrastructure so as to allow for optimal development of irrigation services.
- Improving intra and interregional accessibility.
- Responding to infrastructure needs of existing and future industries.
- Giving priority to maintaining the quality of water, land and air and protecting eco-systems linked to these resources.
- Promoting people's participation in decision-making and project implementation.

The basic components of sustainable development in the GAP region were identified as social sustainability, agricultural sustainability, economic viability, physical and spatial sustainability and environmental sustainability. Environmental and cultural sustainability depend upon the sustainability of natural resources and the conservation of environmental and cultural heritage. Economic viability is closely associated with the implementation of efficient and effective projects, employment opportunities, economic development and involvement of the private sector. Finally, social sustainability rests on the adoption of the principles of participation, equality, fairness and development of human resources [15–17].

3. Water and development

Today, around 3800 km^3 of fresh water is withdrawn annually from the world's lakes, rivers and aquifers. This is twice the volume extracted 50 years ago. A growing population and a rising level of economic activity both increase human demand for water and water-related services. Development, technological change, income distribution and life-styles all affect the level of water demand [2].

World population has passed 6 billion. Although the annual increase probably peaked at about 87 million around 1990, the high proportion of young people in most developing countries means that global population will continue to increase significantly well into this century. On the other hand, recent projections suggest a peak of between 7.3 billion and 10.7 billion around 2050 before