International Journal of Earth, Energy and Environmental Sciences
ISSN: 2517-942X
Vol:5, No:9, 2011

Complexity of Operation and Maintenance in Irrigation Network Management-A Case of the Dez Scheme in the Greater Dezful, Iran

Najaf Hedayat

***Abstract*—**Food and fibre production in arid and semi-arid regions has emerged as one of the major challenges for various socio-economic and political reasons such as the food security and self-sufficiency. Productive use of the renewable water resources has risen on top ofthe decision-making agenda. For this reason, efficient operation and maintenance of modern irrigation and drainage schemes become part and parcel and indispensible reality in agricultural policy making arena. The aim of this paper is to investigate the complexity of operating and maintaining such schemes, mainly focussing on challenges which enhance and opportunities that impedsustainable food and fibre production. The methodology involved using secondary data complemented byroutine observations and stakeholders views on issues that influence the O&M in the Dez command area. The SPSS program was used as an analytical framework for data analysis and interpretation.Results indicate poor application efficiency in most croplands, much of which is attributed to deficient operation of conveyance and distribution canals. These in turn, are reportedly linked to inadequate maintenance of the pumping stations and hydraulic structures like turnouts,flumes and other control systems particularly in the secondary and tertiary canals. Results show that the aforementioned deficiencies have been the major impediment to establishing regular flow toward the farm gates which subsequently undermine application efficiency and tillage operationsat farm level. Results further show that accumulative impact of such deficiencies has been the major causes of poorcrop yield and quality that deem production system in these croplands uneconomic. Results further show that the present state might undermine the sustainability of agricultural system in the command area. The overall conclusion being that present water management is unlikely to be responsive to challenges that the sector faces. And in the absence of coherent measures to shift the status quo situation in favour of more productive resource use, it would be hard to
fulfil the objectives of the National Economic and Socio-cultural Development Plans.

***Keywords*—**renewable water resources, Dez scheme, irrigation and drainage, sustainable crop production, O&M

I.Introduction

RENEWABLE water resources coupled with efficient land use are considered as the most important pre-requites to sustainable food and fibre production in arid and semi-arid regions [1, 2]. This becomes crucial in the face of ever-increasing population growth. The latter places a pressure on demand for irrigation water supply on the farm gates of arid and semi-arid regions to enhance food production on one hand and added demand arising from better economic conditions of a sector of population in some developing nations on the other [3]. These are no exceptions for Iran, where despite rapid growth in design and implementation of infrastructural projects, particularly on water resources development, considerable room for improving operation and maintenance of modern canal networks still remainsas the major consideration.Iran has arid and semi-arid climatic conditionswith a total land area amounting to 1,648,000square km that is situated in the West Asia. It has an average annual precipitation of 250 mm which is normally sparse, intermittent and inadequate to compensate for high average annual Evapotranspiration of about 2500 mm which peaks in July at 3800 mm in the Greater Dezful region, which is an important food-production silo or "keraakheh" as is known locally. The agricultural lands in Iran are approximately equal to the total land area of France, much of which are rain fed and have agreat potential and good scope for infrastructural improvement. The total renewable water resources in the country are estimated at 135Bm^3,out of which about 90 Bm^3 can realistically be abstracted and used. Agriculture is by far the largest consuming sector, using about 90% of the total renewablewater resources that can realistically be abstracted. This, coupled with 25% contribution that it makes to the GNP and its direct and indirect link with employment opportunity (about 30%), the agriculture sector is placed in an important socio-political and economic place in the national policy-making agenda.It is because of such considerations,successive governments have made generous concessions in terms of special subsidies and tax exemptions. Although the latter could have favoured efficient produces if allocated properly, but in the absence of a coherent policy to adapt themselves to the mechanisms of global market, sustenance of these privileges would be problematic. The present practices have reportedly generatedmajor challenges for the economy as food producers have much room to promote their production system as a means of being in line with the competitive global market environment [1, 2, and 3]. Despite recent expansions of modern irrigation and drainage schemes in many crop producing regions like India, Pakistan, Thailand, Iran and Mexico,followed by the Green Revolution which has moderately improved resource use efficiency and food and fibre production, various problems still remain to be solved. One of such challenges is the land reform in certain command

N. Hedayat , Water Engineering Department, Dezful Branch, Islamic Azad University, Dezful, Iran (e-mail: n.hedayat@yahoo.com).

areas where the hitherto large, integrated state-owned and managed farm lands have been redistributed to small holding private farmers. Recent land fragmentation trend not only has undermined the efficiency of resource use but have also affected the viability of crop production in some command areas such as the Dez Irrigation Scheme in Iran. The emergence of these impeding factors has led to challenges and opportunities in modern farming sector. The sustainability of agriculture in arid and semi-arid regions has to be safeguarded against deficiencies of the prevailing farming practices. The paper aims to investigate the complexity involved inthe operation and maintenance of the Dez Irrigation and Drainage Scheme in Iran as a means of enhancing the water supply system that is design to meet the water demand of the crop-producing farmers in the command area.

II. Materials and Methods

The Dez irrigation and drainage scheme is the largest modern network in the Middle East, commanding a gross area of about 120, 000 ha out of a net area of about 90,000 hathat is under cultivation in the form of irrigated agriculture. The Dez region has an arid and semi-arid climate, with sparse and sporadic rainfall pattern. The average annual precipitation in the command area is about 350 mm; the average annual temperature in the study area is 24.8 °C, with a minimum of 4 °C in February that peaks at 55 °C in July. The average annual ET is estimated at about 2522 mm, peaking at about 2735 mm during June-July period and has an average annual humidity of about 50 %. There is plenty of sunshine and a 365-day growing season that makes it suitable for producing a wide variety of crops, e.g. citrus fruits, asparagus, sugar canes, sugar beet, wheat, barely, alfalfa, melon, water melon, and rice and winter flowers. The fine climate has made possible the production of high-economic yielding cash crops such as tomatoes, cucumbers, eggplant and all varieties of beans that are harvested twice a year and have a good export potentials [3].

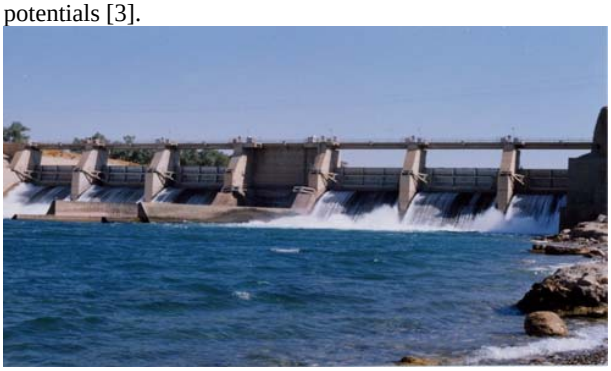

Fig. 1 The Dez regulating Dam with 13000 million cubic meters reservoir

The Dez irrigation and drainage scheme comprises of a hydro-electric dam with a 3 BM^3 capacity, a regulating dam which regulates the flow downstream to the diversion dam of 5 meters height. The regulating dam with a nominal capacity of 13,000 MM^3 has an upstream feeding canal to supply the water for the pumping station that lift water into the 16 M^3 /sec primary canal that is ultimately distributed through the tertiaries to croplands in Sabilli command area of 12,000 ha. The Dez diversion weir is constructed to supply water by gravity flow into two Western and Eastern canals of 150 m^3/second and 85 m^3 /second respectively [4]. The former irrigate the croplands of the Karkheh Plain in the western part of the Greater Dezful food-producing bastion extending to the sugar-cane producing estate of Hafttappeh in the south-eastern Dezful whereas, the later , locally known as the Shahvalli, irrigates croplands of eastern Dezful, extending to as far as the Karun Sugarcane Estate near Shushtar[3].

Fig. 2 The pumping station which feeds the Sabilli command area

The land tenor system of the Dez irrigation scheme is somehow complex as it consists of the large state-owned and managed agro-industrial complexes such as the Karun, Hafttappeh, Shahid Beheshti, Shahid Rajaaaee on one hand and numerous producer cooperatives of medium to small holdings [3] and water distribution regime is based on rigid rotation scheduling managed by the government water agencies [1, 2]. The water charges are fixed according to the crops grown but are charged on 3% of the gross crop value [3].Data used for the purpose of this study included secondary sources complemented by on-farm observations.The croplands were randomly selected from the Sabilli, Karkheh plain and Shavalli from among the large, medium and small holdings that included upstream and downstream croplands. They also consisted of large government-managed agro-industrial complexes which were previously the agri-businesses, the medium cooperative farms and small holding

Fig. 3 A cross- regulator in a main canal

private farms. The SPSS program was used as an analytical framework for data interpretation and analysis.

III. Results And Discussions

Results show that out of 25500 $MM^3$of the regulated water resources, 23,800 MM^3 is allocated for agricultural use. From what it can be observed, the pace of high water consumption in the sector is expected to remain still unrivalled in the foreseeable future with a probability that the present water charges have to increase in order to meet the rising costs of operation and maintenance in irrigation schemes of arid and semi-arid regions. Groundwater extracted from the wells (64%), springs (16%) and aquifers through Qanats (20%) is an important source for agricultural production in arid and semi-arid regions of Iran. Estimates suggest that about one eighth of the annual precipitation is captured by this form of abstraction [3]. Observations suggest that the underground resources have been over-abstracted in some regions considerably more than the rate of recharge. This has prompted governments to limit further uses in some plains and stopping abstraction in others. This is mainly typical at the edge of desert regions where environmental impacts have been considerable. Such state of affairs, as results show, has been the major cause of panic for the stakeholders to take urgent measures for changing the status-quo situation and shift the pattern of underground water usage towards a more viable and sustainable use. Results indicate that a more efficient use of the available surface resources in the form of enhancing their productivity would not only be technically and economically desirable but would also be environmentally sustainable. This, as results indicate, would allow the recharge to take its natural course and water table level reaching its desirable regime. Thatwould be a crucial pre-requisite for avoidingfuture land subsiding that has reportedly been one of the major geo-hydrological and hydro-geological challenge in the Kerman and Yazd Provinces in the heart of the Great Iranian Desert or Kavir as it is known locally [3]. It is because of such analysis that sustainable food and fibre production on one hand and rural regeneration in these regions on the other has to be taken seriously. This should be taken on board by decision-makers in the water sector to lobby for more stringent policy required to protect the physical environmental integrity in future [5]. This is not exclusive to water-short regions but can also be modelled in water abundant command areas like the Dez as a long-term strategy to maintain the integrity ofphysical environment within which these croplands are used as food production base.It was found that the predominantly inefficient water management in the conveyance and distribution networks leads to poor irrigation application efficiency. This was found to be serious and alarming because30% application efficiency in the Dez and 20% in Moghan schemes are low by standard under circumstances of water scarcity that can be the source of intra and inter sector conflicts as research elsewhere indicate [Hedayat 2005]. This,together with the degraded conditions such as soil salinity, soil alkalinity, water table fluctuations and water logging problems which have undermined the fertility of soils and crop production quality are the principal sources that undermine the physical environmental integrity of the scheme in question [6].If this trend is allowed to continue, much has to be done in order to rehabilitate part of the command area as the economic burden of total rehabilitation might prove to be prohibitive given the economic circumstances many are experiencing[1,2].Based on the aforementioned analysis, it would be crucial to take efficient water resources use into considerations and stress on the need to institutionalise high productivity of these vital resources.It becomes important therefore, in takingappropriate measuresto protect the soil structure and texture,surface and underground water resources on one hand and ensuring systematic use of expensive agro-inputs that are necessary ingredients for enhancing sustainability of food production in these croplands on the other [6]. Consideration of such challenges that much of the crop lands are facing, couldbe mitigated and controlledfor ensuring continuity of food-production in general and preserving the environmental integrityin particular[3]. Results indicate that land fragmentation, particularly in the Sabillicommand area has contributed to irrigation application deficiency and poor on-farm performance, both of which have rendered food production system uneconomic and environmentally unsustainable. The larger farm sizes by contrast are shown to have better performance in term of application efficiency and tillage operations that support a wider cropping pattern. This achievement by the large-scale farming enterprises has been instrumental in spreading the risks to more crops than their corresponding small holdings. Analysis of the last two years suggests that poor product markets have adversely affected the small holdings than their large counterparts. More debts has been incurred by the small holdings and still more cases of bankruptcy have emerged in small-holding category that is not desirable, as these are more entrepreneurial than the large farmers.Comparisons of yield and quality in the small and large size farms show an overwhelming advantage enjoyed by the latter which is a serious cause for concern. This supports Hedayat [3] findings which stressed the need for land consolidation as a means of improving operation and maintenance of canal system on one hand and enhancing on-farm application efficiency and economic viability of farming on the other. The status quo situation, as research findings [3] suggest, can hardly be maintained in the ever-competitive market environment. With spirally-increasing food-production costs due to rapid rise in the fuel and transportation costs, all of which take place under circumstances of government withdrawal of farm inputsubsidies, the farming system can no longer afford to risk its sustainability in the light of poor-efficiency farming practices , particularly those that are not agronomically and environmentally viable. Results moreover, suggest that the land fragmentation has become a major impediment to on-farm efficiency in various ways. As observation suggest, croplandfragmentation has limited the flexibility of“on-farm” operations under the Dez command area,making it harder to efficiently manoeuvre the machineries and implements duringthe tillage operations. For example, sowing the seeds, cultivation, pest control activities, weeding operations, irrigation application and harvesting become agronomically harder, more energy-consuming andeconomically costly than

would have been with land consolidation of decades ago. A considerable area of the hitherto fertile cropland goes out of production to make access to each farmpossible and construct separate ditches for irrigation and drainage of the fragmented allotments. Given the ever-rising renting costs of the land, this would be an economic loss to the cash-hardy farmers of the Dez command area. From the perspective of the food producers concerned, fragmentation has increased production costs to the extent of eroding their profit margins, whichunder a poor market conditions like those experienced in the last twoyears, has manifested its impacton the less-well-off crop producers.Fragmentation of the croplands, the argument goes, has been the contributing factor to deficient irrigation application which under the circumstances of water shortage during the draught period of the last few years, is a major cause for concern. The emerging condition, according to the concerned farmers, is environmentally degrading, since much of the water loss and seepage due to poor conveyance precipitate into the underground water table which in their view is environmentally degrading particularly if the run-off contains contaminated agents like agro-chemicals that are excessively used in the intensive farming system of the Dez command area [6].The overall conclusion being that the dilapidated state of hydraulic structures are the major cause of poor operation and maintenance of the canal networks. It is because of these shortcomings in the systems which have overwhelmingly undermined the efficiency of water delivery system. Poor yield and quality have therefore emerged as a results and continuation of which is deemed to make the farming enterprise in the command area in question unsustainable.In the light of globalisation and free competition that follows agricultural system should become economically and environmentally a viable enterprise by maintaining its economic contribution on one hand and preserving the integrity of the physical environment on the other. Achievement of such objective calls for a comprehensive plan and a wholehearted commitment by the stakeholders particularly the governments.

REFERENCES

[1] Hedayat, n [2011]. Challenges of water allocation in arid command areas- a case study of the dez and moghan irrigation schemes in iran. The proceedings of the world academy of science, engineering and technology, 13-15 july amsterdam, netherlands.

[2] Hedayat, N [2011]. Flexible water delivery regime as a viable model for sustainable agriculture – A case study of the Dez irrigation scheme in Greater Dezful region, southern Iran. The proceedings of the World Academy of Science, Engineering and Technology, Paris, 27-29 July, France.

[3] Hedayat, N [2005]. Improving the performance of water delivery in the Dez and Moghan Irrigation Schemes in Iran.Unpublished PhD thesis, Cranfield University, UK.

[4] Sajedipoor,A.H, Hedayat , N and Yazdi,Z[2010]. Analytical study of sedimentation formation in lined canals using the SHARC software-A case study of the Sabilli canal in Dezful,Iran. The proceedings of the World Academy of Science, Engineering and Technology, 71; pp 106-108.

[5] Emamdad, M and Hedayat, N [2011]. Challanges and opportunities facing sustainable development and the effects of knowledged-based approach to environmental protection .The proceedings of the World Academy of Science, Engineering and Technology, Paris, 27-29 July, France.

[6] Taghavi, L and Hedayat, N [2011]. Challenges of irrigation water supply in croplands of arid regions and their environmental consequences- A case study in the Dez and Moghan command areas in Iran.The proceedings of the World Academy of Science, Engineering and Technology, Paris, 27-29 July, France.