I.R. of Iran – Gareh Bygone Plain

Project title: AQUITOPIA (An aquifer management-based utopia)

Case study site: Ahmad Abad, Gareh Bygone Plain, I.R.Iran
Partner institutions: Fars Research Center for Agriculture and Natural Resources (FRCANR); Research Society for Sustainable Rehabilitation of Dry lands (REaSSURED)

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Introduction

We have acquired 1070 ha of a degraded rangeland near the Ahmad Abad village in the SW of Gareh Bygone Plain (GBP, $28^\circ 35' N$; $53^\circ 53' E$; 1150 m above sea level; 210 Km SE Shiraz, Iran). This project is based on aquifer management (AM), which is the application of flood water spreading (FWS) for the artificial recharge of groundwater (ARG), and improving of water use efficiency (WUE). We have convinced the inhabitants of 4 farming communities that surround the AQUITOPIA to form cooperatives to construct the ARG system and benefit from and manage the aquifer for specific purposes. Two of them have registered their cooperative; the other two are in the process of doing so. The study phase of the project started with a grant donated by UNU in 2003. SUMAMAD and Iranian Government have financed construction of 220 ha of a 618 ha ARG system. Construction of the remaining of the ARG system (398 ha), drilling water wells and equipping them with pumping stations, laser land leveling (451 ha) and tree planting cost about 2.5 million US$. Establishment of a "green village" for 110 families shall need approximately another 3 million US$. The bulk of funds are provided through low-interest, long-duration loans supplied to the cooperatives by the Iranian Government. Assuming that we receive the needed funds, construction phase of the project will be ended by December 2013.

Justification

Overuse and improper utilization of the natural resources are the main causes of environmental degradation and desertification processes in drylands. They jeopardize the sustainability of ecosystems, food security and livelihoods in the same areas. As scientists we should try to find solutions to these challenges through participatory action research programmes. Overexploitation of groundwater from the Gareh Bygone Plain (GBP) has caused significant lowering of the water table as well as the deterioration of groundwater quality. Therefore, providing safe water by applying floodwater spreading for the artificial recharge of groundwater and improving water use efficiency are vital for the region.

Achievements / lessons learned from 1st phase of SUMAMAD

a. Policy-makers adopted aquifer management and recharge technologies tested by the SUMAMAD team and allocated funds for up-scaling the technology to serve 1.5 million ha of degraded rangeland;
b. International exposure of the merits of floodwater spreading system for desertification control, particularly through artificial recharge of groundwater;
c. Construction of 220 ha of ARG systems;
d. Formation of REaSSURED NGO;
e. Formation of 2 registered cooperatives by two of the villages benefiting from the ARG systems and persuading the other two villages to form their own cooperatives;
f. Providing the facilities for six PhD and five MS students theses research projects;
g. Holding 4 national workshops, which developed into the government's decision to implement the ARG technology on 1.5 million ha to supply safe water for the water deficient areas?
h. Initiating research project on medicinal plants and characterization of the lining of sow bugs' burrows;
i. Enhanced forage yield (five fold) by introducing spate-irrigation to rangelands;
j. Enhanced carbon sequestration by spate-irrigated tree plantation (Eucalyptus camaldulensis and Acacia salicina);
k. Marketing of honey provides additional income to local people, eco-labeling is being pursued for value addition;
l. Continuation of biodiversity of range plants studies.

Specific objectives

Specific objectives of the project are as follows:

a. Supplying irrigation and safe drinking water;
b. Construction the green village and providing livelihoods for 110 households;
c. Implementing integrated, sustainable natural resources management action research projects (water productivity in agriculture, rangeland management, horticulture, animal husbandry, bee-keeping and conservation of natural resources, etc);
d. Proving that good quality, coarse-grained alluvial aquifers are worthier than oil for desert dwellers;

e. Proving that if wisely used, a sub-marginal resource (degraded rangelands) and a marginal resource (floodwater) could provide a decent livelihood if the will exist.

Major activities

Major activities of the project will be as follows:

a. Completion and maintenance of 220 ha of FWS that has been constructed during the first phase of the SUMAMAD project;
b. Construction of a new 398 ha FWS for artificial recharge of groundwater;
c. Preparation of 451 ha land for irrigation;
d. Formation of two additional registered cooperatives by two of the villages benefiting from the ARG system;
e. Implementing action research projects for the wise management of natural resources;
f. Capacity building of the cooperative members so they will act as honorary extension agents;
g. Introducing income generating alternatives to the cooperatives;
h. Introducing soil and water conservation technologies to the cooperatives;
i. Networking with environment-related NGOs;
j. Campaigning for the inclusion of aquifer management in the global water harnessing policy.

Expected outputs

Expected outputs of the project are as follows:

a. Providing safe water to about 2,500 villagers and 500 nomads, and irrigation water for 451 ha of laser-levelled farm fields;
b. Achieving sustainable income generating alternatives;
c. Improving water use efficiency;
d. As the ARG is achieved by spate irrigation of depleted rangelands, a greener environment is created. Moreover, by keeping the livestock off the flood-producing catchments, their rehabilitation is facilitated;
e. Water security affects all of the 8 Millennium Development Goals to 2015. Thus, the importance of supplying domestic and irrigation water for a water scarce area cannot be over emphasized;
f. Providing conditions for returning environmental refugees to their former abodes.
g. Empowerment of the cooperatives to participate in decision making, planning, implementation, sharing, monitoring and maintenance of aquifer management projects.

The above-mentioned major activities in our project cover the three broad objectives of the 2nd phase of the SUMAMD project. For example, by supplying safe water through ARG and improving water use efficiency, the first objective can be satisfied.

Introducing land use scenarios

By definition, a scenario is an account or synopsis of a projected course of action, event or situation. Scenario development is used in policy planning, organizational development and, generally, when organizations wish to test strategies against uncertain future developments.

Floodwater spreading provides different opportunities for the decision maker in desertification control. According to the literature the floodwater spreading (FWS) projects are usually multipurpose and follow rules such as:

1- To control and manage the flood with minimal cost.
2- To increase groundwater level and prevent water waste.
3- To convert deserts (with coarse texture fan) to rangelands, forest and agricultural land.
4- To pave the way for an unutilized land to be changed to an agricultural land by groundwater replenishment.
5- To combat desertification by rangeland improvement and afforestation.
6- To increase agricultural productivity by returning abandoned farmlands through increasing soil moisture and groundwater level.
7- To ameliorate the environmental qualities and mitigate climate change hazards.
8- To manage the arid land sustainability.

These goals can be specialized for desertification control as follows:
1- To control desertification by regenerating natural vegetative cover (rangeland improvement).
2- To rehabilitate desert (with coarse texture) by afforestation.
3- To increase wind erosion resistance of sandy soils by covering them with the suspended load.
4- To combat desertification by creating spate-irrigated farmlands.
6- To establish shelter belt.

According to these goals and abilities, six scenarios were defined as mentioned below:

1. Rainfed improvement through spate irrigation
Spate irrigation is an ancient form of water management, involving the diversion of flashy spate floods running off from mountainous catchments. The creation of spate-irrigated farmland is the first recommended scenario for combat desertification. The main goal of this scenario is combat desertification by creating spate-irrigated farmland. The case study results have been indicated the yield of rainfed farms in GBP increased to more than 3.5 ton per hectare (for barley variety Trophy) just with two times irrigation farm by floodwater (spate irrigation).

2. Afforestation
Floodwater spreading provides desirable conditions through soil moisture and fertility improvement for afforestation in dry lands. The rehabilitating of desert area by planting trees is followed in this scenario. The tree plantations not only conserve soil and decrease wind erosion but also provide significant benefit through producing fruits, and industrial and fuel wood. The case study results in GBP have been shown, the wood production were 3619 kg/ha/year in the productive site and 2273 kg/ha/year in poor site.

3. Rangeland improvement
Iran is called a land of floods and droughts because even during severe droughts flood occurrences have been noticed. Keeping an effective vegetative cover is the most logical way to prevent soil degradation (desertification control). Rangeland improvement through FWS is another scenario for desert mitigation. A 9 years research in GBP have been indicated there was

a 7 – fold increase in the visible forage yield and 2 - fold increase in the canopy cover in FWS implemented sites.

4. Regenerating natural vegetation cover (preserve)
The main objective of this scenario is desertification control through moving sand fixation with floodwater carried sediment and increasing soil moisture to regenerate natural vegetative cover. The protection of FWS implemented site from grazing will be done in this scenario for returning natural vegetation to climax.

5. General vegetation covers improvement
If vegetation cover improvement in any form is wanted (from FWS performance) the combination of two or more of the above scenarios for vegetation covers improvement (General scenario) can be used.

6. Best in benefit cost ratio
Gaining maximum outcome from FWS implementation will be possible if one of the above scenarios is chosen that provides the most profit per total costs per hectare (the most beneficial cost ratio scenario). Some researches in GBP reported spate irrigation for rainfed improvements is the best option in benefit cost ratio.

DECFWS Decision Support System
Optimization of the existing floodwater spreading schemes (more than 200,000 ha in Iran) lead to develop a Decision Support System (DSS) that facilitates selection and planning of the most appropriate sites for FWS according to the best scenarios for desertification control. This is the doctoral thesis problem of Mr. Masoud Nejabat at University Putra, Malaysia. Desertification Control through floodwater Spreading (DECFWS) is a software that has seen many overhauling and revision, the latest of which has been designated as DECFWS 3.31.

DECFWS 3.31 is a special DSS package developed under the Visual Basic. This software can help decision makers easily in selecting:

1. The most appropriate alternative for a chosen scenario;
2. The most reasonable scenario for each alternative;
3. The most desirable alternative in benefit-cost ratio;
4. The most appropriate alternative in general (for several scenarios);
5. The irrelative alternatives for SI, the ARG and the relevant consternation; and
6. The sensitivity analysis of ranking for uncertain effects value.

DECFWS 3.31 is able to accept new effective factors, scenarios, effects value uncertainty, effects weighting and constraints, and present different kind of printed reports in forms of attributes, tables and graphs.

5 year work plan for the 2nd phase of SUMAMD project
Our NGO (REaSSURED) is registered by the Government of I.R. Iran. We believe sustainable management of natural resources in drylands can be achieved through participatory approaches

of the inhabitants in the same area. AQUITOPIA will be governed by an executive committee comprising representatives of the cooperatives and our NGO.

The main proposed activities for the 2nd phase of the SUMAMAD project are as follows:

a. Empowerment of members of the cooperatives to complete the AQUITOPIA project, to manage it and to benefit from it;
b. Introducing income generating alternatives;
c. Introducing soil and water conservation technologies to cooperatives;
d. Continuation of the research activities, which have been started during the first phase of SUMAMAD;
e. Implementing new proposed research activities for the 2nd phase of SUMAMAD;
f. Sharing our experiences in the field of water harvesting and soil and water conservation technologies through sustainable development of drylands with other countries, which are involved in the SUMAMAD project;
g. Encouraging Iranian Government authorities to fund the AQUITOPIA project.

Proposed five year work plan for the 2nd phase of SUMAMAD, detailed work plan and budget for 1st year and composition of the research team are shown in Tables 1, 2 and 3, respectively.

Counterpart contribution per year (in US Dollars):

	2009	**2010**	**2011**	**2012**	**2013**	**Total**
SUMAMAD Member State	233,500	1,335,625	1,335,625	1,335,625	1,335,625	5,576,000

Table 1: Proposed five year work plan in the Gareh Bygone Plain, I.R.Iran

MD d ves	Specific case study objectives	Activities	Condition	Outputs	Duration		Budget (US$)
					from	to	
ic	Improvement of dryland agriculture	Efficiency of flood water spreading on net recharge of the aquifer	New	Determination the quota of FWS on net recharge among the multiple sources of recharge of the Gareh Bygone	2009	2013	20,000
		Jojoba trial	Continued	Determination the effect of spate irrigation on the adaptation and performance of jojoba	2009	2013	3,000
		Biodiversity study	Continued	Monitoring of range plant biodiversity of the Gareh Bygone	2009	2013	6,000
		Sow bug study	Continued	Determination of the lining tunnel materials of sow bug for replace with the petroleum sand dune mulching	2009	2010	3,000
		Construction of FWS and green village	Continued	Supplying safe water and sustainable livelihoods	2009	2013	5,500,000
t s	Developing scenarios for landuse change	Empowerment of the cooperatives	New	Empowerment of the cooperatives to participate in decision making, planning, implementation, sharing, monitoring and maintenance	2009	2011	10,000
		National workshops	Continued	Extension the results of SUMAMAD to cooperatives	2009	2013	20,000
able ods	Alternative income generating activities	Spate irrigated barley (tropy variety) trial	New	Substitution of irrigated crops with spate irrigated barley	2009	2010	2,000
		Honey production	Continued	Use of honey production potentials of the project to introduce a new income generation	2009	2010	5,000
		Socio-economic analysis of income generating alternatives in Gareh Bygone Plain	New	Recognition of the socio-economic priorities of the income generating alternatives	2009	2010	10,000
							5,579,000

Table 2: Proposed detailed work plan of 1st year in the Gareh Bygone Plain, I.R.Iran

SUMAMD broad objectives	Activities	Identification of items	Budget (US$)					
			Total			1st year		
			Amount	SUMAMAD	FRCANR & REaSSURED	Amount	SUMAMAD	FRCANR & REaSSUTED
Scientific studies	Efficiency of flood water spreading on net recharge of the aquifer	Digging the wells, insertion the sensors, infiltration measurements, sampling, soil analysis, data loggers, surveying, transportation, perdiem, salary	20,000	20,000	0	6,000	6,000	0
	Jojoba trial	Fence completion, weeding and cultivation transportation, perdiem, salary	3,000	3,000	0	600	600	0
	Biodiversity study	Vegetation measurements, species identification, transportation, perdiem, salary	6,000	6,000	0	1,200	1,200	0
	Sow bug study	GC/mass spectrometry, identification of organisms, transportation, perdiem, salary	3,000	3,000	0	600	600	0
	Construction of FWS and green village	Construction and maintenance of FWS, transportation, perdiem, salary	5,500,000	26,000	5,474,000	222,000	2,000	220,000
Policy-relevant analyses	Empowerment of the cooperatives	Relationship with people, analysis of the present situation, education and extension, transportation, perdiem, salary	10,000	10,000	0	2,000	2,000	0
	National workshops	Advertisements, announcement, executives, , transportation, perdiem, salary	20,000	20,000	0	4,000	4,000	0
Sustainable livelihoods	Spate irrigated barley (Toropy variety) trial	Cultivation, maintenance and harvesting of barley, education and extension, , transportation, perdiem, salary	2,000	2,000	0	1,000	1,000	0
	Honey production	Beehive transportation, maintenance, disease protection, adaptation to the dry condition, analysis of the honey, transportation, perdiem, salary	5,000	5,000	0	1,000	1,000	0
	Socio-economic analysis of income generative alternatives in the Gareh Bygone Plain	Study on potential income generation alternatives with participatory approach, economic and sociologic analysis, transportation, perdiem, salary	10,000	10,000	0	2,000	2,000	0
		Total	**5,579,000**	**105,000**	**5,474,000**	**240,400**	**20,400**	**220,000**

Table 3. Composition of the research team

Names	Degree	Area of expertise	Experience (years)	Role
Mehrdad Mohammadnia,	Ph.D.	Soil Science& Environmental Pollution	27	Team leader
Mansour Esfandiari Baiat,	Ph.D.	Irrigation, Agricultural Water Management	28	Deputy team leader
Sayyed Ahang Kowsar,	Ph.D.	Aquifer Management	40	Scientific advisor
Mazda Kompani Zare	Ph.D.	Groundwater Modelling	12	Scientific advisor
Donald Gabriels	Ph.D.	Soil Physics		Scientific adviser
Gholamreza Bajian	Ph.D.	Range Management	20	Scientific adviser
Gholamreza Chabokrow,	Ph.D.	Agricultural Economics	20	Project leader
Mojtaba Pakparvar,	M.S.	RS-GIS, Soil and Water Conservation	15	Project leader
Gholamreza Ghahhari,	M.S.	Geomorphology	16	Project leader
Sayyed Morteza Mortazavi Jahromi,	Ph.D.	Forest Management	25	Project leader
Sayyed Hamid mesbah	M.S.	Watershed Management, Groundwater Hydrology	20	Project leader
Gholamreza rahbar	M.S.	Soil science & Desert Management	17	Project leader
Mohammad Javad Roosta	Ph.D.	Soil Microbiology	12	Project leader
Jafar Zabetian,	M.S.	Civic Architecture	20	Project leader
Hamid Hoseini Marandi	M.S.	Geology, Sedimentology	18	Project leader
Mazaher Safdarian,	M.S.	Animal Husbandry	17	Project leader
Shahrokh Shajari,	Ph.D.	Agricultural Economics	15	Project leader
Mohammadreza Dehghani	Ph.D.	Fluid Mechanics	28	Team Member
Behrouz abolpour,	Ph.D.	Irrigation and Drainage	10	Team member
Zahra Khoogar,	M.S.	Soil Science	23	Team member
Bahman Ilami	M.S.	Animal Husbandry	17	Team Member
Sayyed Kazem Bordabar	Ph.D.	Forest Management	15	Team Member

Mohammad Javad Agah	M.S.	Animal Husbandry	13	Team Member