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Sustainability Impact Assessment of Watershed Programs

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Abstract

This paper assessed the impacts of watershed programs (WPs) on agro-ecosystemsin Hamedan Province, Iran. This study's methodology was based on criteria for the comparison of agro-ecosystems with and without WPs and nine indicators was selected to assess the sustainability impacts. The results revealed that WPs have contributed in raising the stability, productivity and relative acceptability of the agro-eco-system by improving the indicators for ecological sustainability,generating a better benefit-cost ratio and promoting the quality of life and access to public services for farmers in agro-ecosystems with a project. However, the involvement of stakeholders in program implementation and monitoring has reduced. At the end, we recommend demand-driven WPs rather than supply driven ones to be increase the social acceptability of WPs.

Keywords: Assessment, Agricultural Sustainability, Watershed Programs, Iran

1. Introduction

Concern about widespread soil degradation and scarce, poorly managed water resources has led to the spread of watershed management investment throughout Iran (Golrang et al., 2006). Despite the growing importance of watershed projects as an approach to rural development and natural resource management, to date there has been relatively little research on their impacts. So, despite the high political priority of the sustainable management of the country's land and water resources in Iran and elsewhere, the contribution of these projects to equity, the quality of life, and perceived wellbeing of rural community seems more uncertain (Ahmadvand and Karami, 2009). Therefore, research is needed to ensure that new projects supply agro-ecosystem sustainability.In order to obtain spatially and temporally acceptable indicators here, in view of biophysical and socio-economic conditions in the study area in the previous studies (Farshad and Zinck, 2001; Ali-Beigi and Baboli, 2008; Hayati and Karami, 2007; Ireavani and Darban-astaneh, 2004; Shahi et al., 2009; Hashemi et al., 2010; Hosseini et al., 2007; Allahyari, 2010; Ahmadvand et al., 2009; and Veisi et al., 2012) 9 indicators representing ecological, economic and social impacts of watershed projects were selected.

2. Methods

A causal comparative method was used to understand better the sustainability impacts of the WPs at Gonbad-chai watershed. Two villages – Gonbad-chai and Tahon-abad – were meant to be the beneficiaries of the WPs and so they were included in the study as villages of agro-ecosystem with the watershed program. The villages of Bagche, Sabz-abad and Gorgoz also were selected as the villages in agro-ecosystem without WPs that located in the same watershed basin as the watershed project villages; have similar cultural and social characteristics; and be relatively close to the villages with WPs. Face-to-face interviews were used to collect data with the aid of a questionnaire containing open and closed questions. The sample size for the household survey was determined by using the formula given by Cochran (1977). Altogether, 69 households were surveyed from an agro-ecosystem with WPs and 67 from an agro-ecosystem without WPs, representing above one-third of the households of each area. The social impact items were categorized according to three social criteria. They include: quality of life (7 items); access to public services (6 items); social capital and social structure (6 items). The economic impact item was marginal cost-benefit ratio. The ecological impact items were categorized into five ecological criteria as follows: crop management (10 items), biodiversity (5 items), soil health (9 items), hydrological processes (2 items) and energy (5 items) (Table 2). Weighting the data was undertaken using conjoint analysis such as Sydorovych and Wossink (2008) and the data were standardized; the weight of each indicator is shown in Table 1. A 'T' test was employed to test the differences between agro-ecosystems with and without WPs.

3. Results

3.1. Impacts of the WPs across the social criteria

Quality of life: The analysis of the impact of WPs on rural quality of life indicated that there were no significant differences in quality life between agro-ecosystems with (X= 43.07) and without WPs (X= 40.81, T = 1.59; P> 0.05). It is concluded that the respondents in villages with WPs believed their quality of life has improved. This is somewhat congruent with the findings of Ahmadvand and Karami (2009), regarding the impact of sustainable land and water resources management on the quality of life of the rural community. However this result is opposite to the causal conclusions of Kerr and Chung (2001), which expressed that landless people felt harmed by the projects, but to create jobs for these people in the study area is different from the results.

Access to public services: Equality of access to public and support services can ensure social stability and encourage farmers to improve production while conserving resources (Dang, 2001). The findings suggested that there was a significant difference between agro-ecosystems with (X= 47.87) and without WPs (X = 38.53) with regard to access to public services (T=4.79; P<0.001). Increase in access to public services in agro-ecosystem with WPs is relation to the distance between this villages and urban areas. The status indicator has not been reported in other studies.

Social capital: Comparison of social capital showed significant difference (T=2.65; P<0.01) between agro-ecosystems with (X= 72.69) and without WPs (X = 78.57). The respondents in agro-ecosystem with WPs perceived that their social capital had declined. These results are consistent

Indicators	Weight indicators	Watershed projects				P	T
		Without		With			
		SD*	Average	SD*	Average		
Quality of life	.069	40.81	8.43	43.07	8.09	-1.597	.113
Access to public services	.084	38.53	11.78	47.87	10.98	-4.786	.000
Social capital and social structure	.070	78.57	10.77	72.69	14.71	2.654	.009
Cost-benefit ratio	.015	49.15	13.09	65.34	13.67	-7.050	.000
Crop management	.019	43.90	5.46	46.06	5.24	-2.351	.020
Biodiversity	.045	46.86	20.76	61.74	17.74	-4.486	.000
Soil health	.108	54.63	6.85	58.76	5.72	-3.821	.000
Hydrological processes	.091	44.13	6.63	54.27	14.89	-5.104	.000
Energy	.064	55.90	9.95	69.21	11.17	-7.333	.000

Table 1. Comparing the sustainability criteria and the weight of each indicator

with the findings of Ahmadvand and Karami (2009), and in contrast with the results of Brouwer and Van Ek (2004) which who concluded that the new policy of water management in The Netherlands improved the social capital of farmers.

3.2. Impacts of WPs across the economic criteria

Cost-benefit ratio: Comparison of the cost-benefit ratio showed significant difference (T=7.05; P<0.001) between agro-ecosystems with (X= 65.34) and without WPs (X=49.15). In other words, the marginal cost–benefit ratio was raised in agro-ecosystem with WPs. The patterns of these findings are congruent with recent development efforts in rural Iran, such as those described by Ahmadvand and Karami (2009), Golrag et al. (2006), Parizanganeh et al. (2008) and Sadeghi et al. (2003).

3.3. Impacts of WPs across the ecological criteria

Crop management: Comparison of crop management showed strategies significant difference (T= 2.35; P< 0.05) between agro-ecosystems with (X=46.06) and without WPs (X=43.90). It seems that improvements in farm management practices are the effect of an increase in economic power, better access to agricultural experts and an increase in knowledge and education. The status indicator has not been reported in other studies, but some components of the indicator, such as farm size, agree with the results of the study of Parizanganeh et al. (2008).

Biodiversity: The above facts clearly indicate that the WPs altered the land use system in favour of hourticultural crops, mostly fruits. The findings susggested that there was significant difference in agro-ecosystem with (X=61.74) and without WPs (X= 41.86) with regard to access to pub-

lic services(T=2.35; P< 0.05). This confirmed with the findings of Palanisami and Kumar (2009) and Singh and Prakash (2010).

Soil health: The analysis of the effect of WPs on soil health indicated that there were significant differences in soil health between agro-ecosystem with (X=58.76) and without WPs (X=54.63, T=3.82; P<0.001).This was in agreement with the findings of Palanisami and Suresh Kumar (2009), who noted the positive impact of a watershed management project to protect, fertility and organic matter in the soil.

Hydrological processes: Better-performing projects have been based on promoting communities' traditional water harvesting and conservation practices (Sharma, 2003: 76). The findings suggested that there was a significant difference in agro-ecosystems with (X = 54.27) and without WPs (X = 44.13) with regard to hydrological processes (T=5.10; P<0.001). Also, improvement in hydrological conditions also conforms to the results of studies Ahmadvand and Karami (2009) and Palanisami and Suresh Kumar (2009).

Energy: Comparison of energy showed a significant difference (T=7.33; P<0.001) between agro-ecosystems with (X=69.21) and without WPs (X=55.90). Improved energy indicators were seen, thus increasing yield, reducing energy used for pumping water and use of surface water for irrigation. The status indicator has not been reported in other studies.

In order to achieve an adequate integration and synthesis of the results, on AMOEBA diagram was used (Lopez-Ridaura et al., 2002). This diagram shows, in qualitative terms, to what extent the objective has been met for each indicator and it enables a simple, yet comprehensive, graphical comparison to be made of the advantages and limitations of WPs under evaluation (Fig. 1). Comparing the results of agro-ecosystems with and without project revealed that project had negative impacts on some social criteria, including development of social capital and social structure. Also, the project had a positive impact on indicators of access to public services, rural and agricultural economic conditions, crop management procedures and conservation of community resources, such as the conservation of biodiversity and water resources.

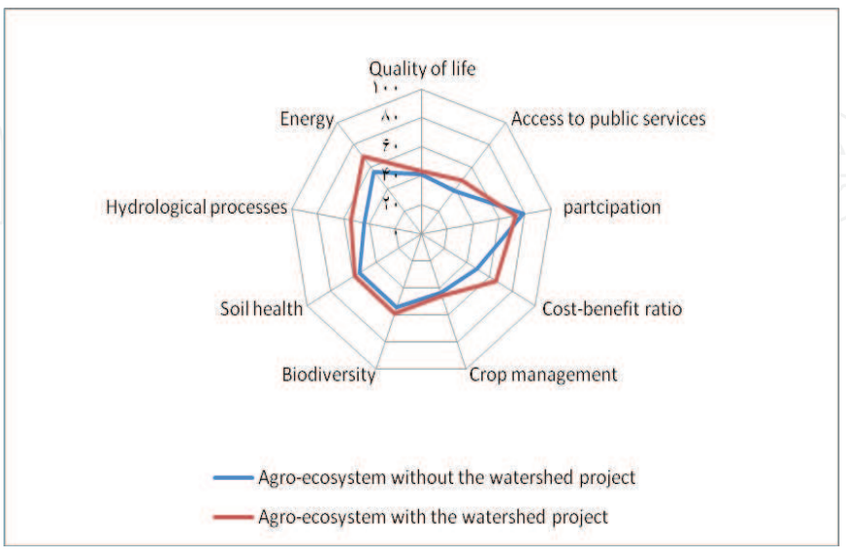

Fig 1. Integration of sustainability indicators for two agro-ecosystems using an AMOEBA diagram

4. Conclusions

The analysis showed that the impacts and benefits of the watershed program were significantly greater in those agro-ecosystems with WPs as compared to agro-ecosystems without WPs. Based on the findings of this study, it can be said that WPs have contributed to raising the stability of the agro-eco-system by improving the ecological sustainability indicators such as biodiversity, soil health, hydrological process, energy use and crop management. This is in accordance with the conclusions obtained by Joshi et al. (2008) who cited that a watershed program provides multiple benefits in terms of conserving soil and water resources. This finding also verifies the conclusions of Altieri (2009) who stated that the farmer can increase the stability of the agro-ecosystem by adopting key ecological management practices. In terms of economic efficiency, WPs generated a better benefit-cost ratio. Following Joshi et al. (2008) and Sreedevi et al. (2006), it can be concluded that the watershed program is a vehicle of development to raise farm productivity, so that investing in a watershed program will increase good net present value and internal rate of returns, while maintaining a good environment and soil –to- water balance in the watershed. Concerning social indicators, in agreement with the conclusions of Ahmadvand and Karmai (2009), the findings indicated that the projects had negative impacts on farmers' participation and it had positive impacts on quality of life and access to public services for farmers in agro-ecosystems with a project. Thus, projects initiated in the study area to improve the conditions of rural communities in dry regions appear to be socio-economically acceptable but socio-culturally undesirable. According to these findings, although increased income from agriculture alongside better access to public services enabled farmers to improve their standard of living; their level of participation declined. These findings are contrary to expectations that the project would have positive social impacts on rural communities. We interpret this anomaly with regard to the fact that this generation of WPs in the study area was supply-driven, so that government officials identified locations and decided on various activities for the implementation of WPs (Sreedevi et al., 2006). In contrast, Joshi et al. (2008) asserted that important conditions of people's participation are related to (1) demand-driven watershed projects rather than supply driven ones, (2) involvement of all stakeholders in program implementation and monitoring and (3) decentralization of the decision-making process.

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