

# An Effective Participatory-Based Method for Dam Social Impact Assessment

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## Abstract

Every type of construction project, including reservoir dams, along with undeniable positive impacts has always been coupled with inevitable adverse side effects on the environment. Therefore, it is necessary to adopt appropriate managerial measures for mitigating the adverse effects and preventing serious disruption to the life of people affected by the project. Accordingly, the current study was carried out with the aim of applying a new method called "Monavari 2001" to assess socio-cultural impacts of the Siah Bishe Dam within constructional and operational phases. For this purpose, a total number of 94 questionnaires were distributed among relevant experts. In order to interpret the questionnaires using SPSS software, all the questions have been coded separately. The obtained results suggest that about 33.7% of total temporary impacts related to the constructional phase are positive, while approximately 66.2% of them are estimated to be negative. Meanwhile, around 80% of the total permanent impacts are positive and the rest are negative. In other words, the long-term positive impacts have dominance over the negative consequences. The current study shows how the Monavari 2001 method can be affective in handling social impact assessment studies.

**Keywords:** dam, social impact assessment, Monavari 2001 method, Siah Bishe

## Introduction

In the early 21<sup>st</sup> century, one of the most important global concerns facing communities is water supply, which does not meet human needs in terms of either quantity or quality. Considering that Iran is situated in a semi-arid area, the optimal and sustainable use of available water resources has always enjoyed a special position in construction and development programs of the country. Meanwhile, a reliable supply of water for different purposes is very important, especially where there is high potential for farming or generating hydroelectric energy from water currents. Regarding the importance of the issue, a lot of feasibility studies have yet to be done [1]. Tilt et al. [2] assessed social impacts of large dam projects on human communities. They focused on

similar international projects to present the best practical procedure for Social Impact Assessment (SIA). Ahmadvand et al. [3] examined utilization of Social SIA in Iran in terms of policy context and applicability. They concluded that there are serious problems associated with the way SIA is undertaken. Wyrick et al. [4] analyzed both physical and social impacts of the removal of two small dams in southern New Jersey. They concluded there is a widening gap between policy makers and landowners, and highlighted where complete stakeholder interaction could and should happen. In 2009, Ahmadvand and Karami [5] conducted research on social impact assessment of the floodwater spreading project on the Garih-Bygone Plain in Iran. They concluded that in spite of negative impacts on perceived wellbeing, social capital, and social structure development; the project had a positive impact on quality of life, rural and agricultural economic conditions, and conservation of community resources.

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Construction and operation of development projects, including pumped-storage dams, regardless of undeniable positive effects, impose inevitable and adverse impacts on socio-economic characteristics of the environment. Accordingly, along with implementation and operation of such plans, some studies are to be done in the case of identifying appropriate strategies to manage adverse impacts derived from these kinds of projects [7]. Consequently, serious disruption to the life of indigenous peoples affected by the projects could be avoided [8]. The biggest turning points in human history have emerged along rivers. Much later, another turn occurred along rivers in northern England to provide power for industrial plants [9, 10]. In spite of all beneficial effects obtained from economic projects such as dams, various difficulties and complexities, including ecological, political, social, and economic dilemmas, may slow or even halt final development [11]. Reservoirs have flooded vast areas of land. At least 400,000 km<sup>2</sup> in the world is submerged under artificial lakes of dams [12]. A large part of the world population lives in tropical, sub-tropical, and arid regions wherein they are willing to meet their water supply needs by dam construction. In arid areas, there is more emphasis on agricultural, potable, and industrial water supply while in cold regions flood control and portable electricity supply are rather more important. Undoubtedly, secondary objectives such as construction of artificial lakes for recreational purposes, fisheries and flood control also can be considered in all large hydropower projects [13]. However, construction of massive dam structures, especially in areas suffering from extreme drought, causes major, sudden changes in society, agriculture, industry, and power generation, together with ecological and biological variations changing the environment entirely [3, 14-16]. If the mentioned changes are associated with improved conditions, then the society will face sustainable development, biological, and ecological balances as well as economic prosperity [17, 18]. Nonetheless,

some of the projects indicate that these developments do not always act in a positive direction [19, 20]. Normally, the adverse consequences lead to a loss of national capital. Thereby, it will impose large costs on society to mitigate the negative impacts. Impacts on livelihoods, health, social systems, and cultures are considered among indivisible functions of large dams. Dams are considered infrastructure constructed for the purpose of economic development in a region, country, or basin [4, 23]. Direct benefits provided by dams are usually accompanied by negative impacts on many people and communities, as well. Therefore, a social impact assessment of dams can play an important role in promoting social sustainability. The current research is a result of the achievements obtained from literature reviews, field studies, questionnaire distribution, and analysis of impact assessment matrices in both constructional and operational phases. It revealed the situation of the study area regarding environmental and socio-economic features. Following the identification of potential losses, it recommends some mitigation measures in the framework of a management plan.

## Material and Methods

### The Study Area

The Siah Bishe Pumped-storage Power Plant and Dam are located in Siah Bishe, a mountainous village in northern Iran (between the longitudes of 15°, 18' to 51°20'E and latitudes of 36°, 10' to 36°, 14'N) near the roaring river of Chaloos. The highest point of the basin has an altitude of 3,800 meters above sea level. Both down and upstream reservoirs collect the water of the Chaloos River as well as its floodwaters. The watershed area of the upstream dam is 19 km<sup>2</sup>. The Siah Bishe Project consists of two dams in up- and down-contours laid on the Chaloos River, their related

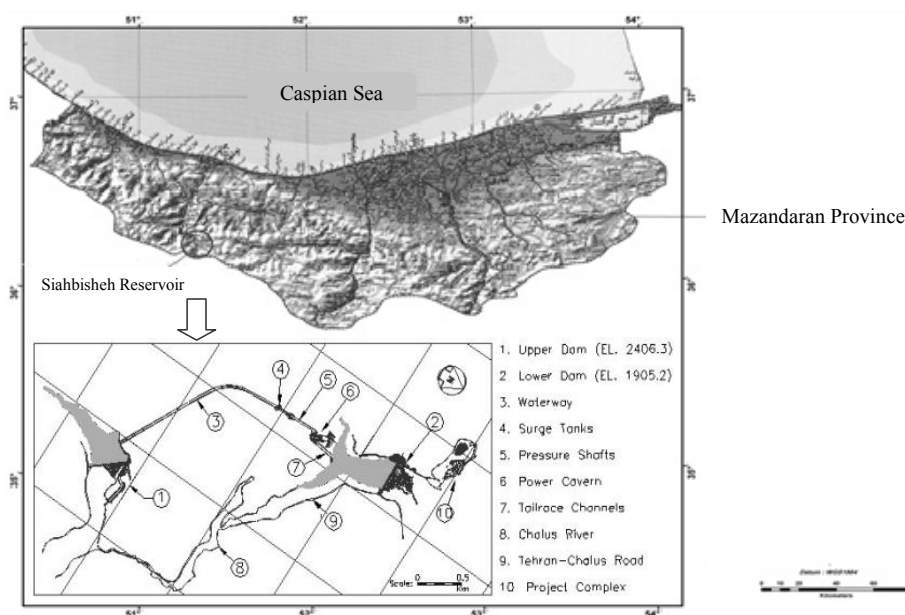


Fig. 1. The location of the project in Iran.

structures (spillway, diversion tunnels, injection, and drainage tunnels, etc.) and an underground power plant with its associated structures (up- and downstream water supply tunnels, transformer cavern, drainage tunnels, drains, under pressure tunnels, pressure-relief reservoir, and water inlet and outlet structures of the plant). The position of the study area is shown in Fig. 1.

### Research Workflow

Considering that there were no similar studies in Iran, a procedure was initially prepared to clarify the research methodology. Therefore, this study was performed based on the following steps. In each step, it was tried to fix deficiencies of the previous level by using the following processes and methods.

1. Literature reviewing based on the main research issues.
2. Referring to the departments and offices, including the Department of the Environment (DOE); the Meteorological Organization in Mazandaran Province; the Department of Natural Resources in Mazandaran Province; the Mosha Niroo Company and other companies affiliated with the Ministry of Energy, Energy and the Environment; the Department of Science and Research Branch at Islamic Azad University of Tehran; and the Research Center of Natural Resources and Animal Affairs (RCNRA).
3. Conducting field studies to visit the study area and complete the questionnaires.
4. Analyzing the findings.
5. Presenting obtained results in the form of maps, graphs, tables, and photos to achieve better understanding among the individuals.

It is noteworthy that the study area was initially examined regarding socio-economic, biological, and cultural points of view. To conduct socio-economic studies, a questionnaire was designed to gather census information on the households living in the study area. Afterward, the collected data was analyzed using SPSS software. Finally, GIS software was applied to prepare thematic maps.

### Questionnaire Analysis

In the current study, in order to gather public opinions, implement the project through a simple process, and minimize opposition, a public participatory approach was adopted. Accordingly, a questionnaire was design to identify the viewpoints of all stakeholders. A questionnaire is one of the best tools for conducting a public participatory approach in the decision-making process. It can be used to identify all those who are somehow involved in the project. Better results will be achieved if the query is accompanied by interviews.

#### Sample Size and Number of Questionnaires

When responses to the questionnaires are given in nominal categories (like questionnaires designed in the current

research), the following equation is applied to calculate confidence level.

$$p \pm \sqrt{\frac{pq}{n}} Z_a \tag{1}$$

...where:

- $n$  – total number of statistic society
- $P$  – estimation of the ratio for one case occurrence
- $1-P$ – estimation of the ratio for failure in occurrence of one case
- $Z_a$  – Standard normal variable rate at the confidence level

It should be mentioned that standard error of ratios can be calculated through the following equation:

$$s = \sqrt{\frac{pq}{n}} \tag{2}$$

- $s$  – standard error of ratios
- $q$  – estimation of the ratio for failure in occurrence of one case

The desired confidence level is usually obtained at 0.5 confidence intervals. In such a confidence level, the standard normal variable rate is equal to 1.96. It should be noted that the standard error of ratios reaches its maximum value when  $p$  and  $q$  equal 0.5. Ratio estimation error in the above formula is obtained via the following equation:

$$d = \frac{pq}{n} Z_a \tag{3}$$

The above equation can be used to calculate the number of samples required to estimate a proportion in population with an error ratio equal to  $d$ . Thus, eq.1 can be written as follows:

$$n = \frac{pqZ_a^2}{d^2} \tag{4}$$

The sample size should be increased by whatever is necessary to lower the error rate. Furthermore, however the amounts of  $p$  and  $q$  are different from 0.5, the standard error is decreased, as well. Therewith, the number of samples is reduced. Considering the error to approximately 10% in all ratios, the sample size was estimated at 94. In other words, it is necessary to fill a total number of 94 questionnaires on socio-economic status of the households in the study area. All the questionnaires were randomly distributed among indigenous people and relevant experts in environmental studies, those who were familiar with the area as well as various aspects of the project activities in the two phases of construction and operation. The questionnaire was designed to specify impacts and scope of each activity in constructional and operational phases.

After completing the questionnaires, the obtained data were analyzed. For this purpose, the questionnaires were initially coded to use information easily. In this way, the applicability of data is increased and it would be possible to analyze qualitative data in the environment of Excel and SPSS.

Monavari 2001 Method

The Monavari 2001 method offers a range of codes to classify the impacts through two main matrices (Tables 1 and 2). The preliminary Environmental Impact Matrix (PEIM) presenting 26 types of impacts can be a comprehensive guideline to meet the needs of SIA.

Results and Discussion

Number of Samples Used in the Study

Given that in this research 94 questionnaires were completed, by knowing the highest standard errors, the highest error in the estimates was calculated as follows:

$$d = \sqrt{\frac{pq}{n}} Z_{\alpha} = \sqrt{\frac{0.5 \times 0.5}{94}} 1.96 = 0.101$$

Therefore, the maximum possible error in estimating ratios is approximately equal to 10% and occurs when the desired ratio equals 0.5. In other cases, the error would be less than this amount. For example, if the theoretical estimation is equal to 86.2% (the percentage of people applying for their compensation through cash), the error made in estimating the real rate of the ration in the society is calculated as follows:

$$d = \sqrt{\frac{pq}{n}} Z_{\alpha} = \sqrt{\frac{0.862 \times 0.138}{94}} 1.96 = 0.069 \approx 0.07$$

In other words, 7% error will occur in the above estimation given the applied sample size. The actual estimated rate (at confidence level of 95%) is tantamount to  $p \pm d = 86.2 \pm 0.069$ .

Accordingly, 95% is likely that the actual proportion of people willing to receive cash compensation is in the range of 93.1 to 79.3.

Social Impacts of the Project in Construction Phase

*Job creation:* Currently, economic status in the study area consists mainly of service activities, such as working in hotels or restaurants, and in the second degree, animal husbandry and farming on a small scale. Most of the occupations are available in summer, therewith; the local laborers migrate to nearby cities for earning livelihoods. Due to the manpower requirements at the constructional stage for installation of the equipment and other activities, it can be concluded that job creation in the constructional phase is the most important positive impact in the short-term.

*Increase in income and living standards:* Job creation and spending various expenses through implementation of the project increases incomes and improves the living standards of the inhabitants.

Table 1. Determine the type of impact.

Impact type	Code
Positive	1
Negative	2
No impact	3
Need for more information	4
It is not possible to judge	5

Table 2. Preliminary Environmental Impact Matrix (Monavari 2001 Method).

Impact type	Code
Very high	A
High	B
Moderate	C
Low	D
Negligible	E
Significant	F
Insignificant	G
Certain	H
Probable	I
Reversible	J
Irreversible	K
Short-term	L
Long-term	M
Direct	N
Indirect	O
Avoidable	P
Unavoidable	Q
Mitigable	R
Unmitigable	S
Temporal	T
Permanent	U
Cumulative	V
Strategic	W
In-situe	X
Local	Y
Extensive	Z

*Land use change:* According to the current land uses of the study area, including rangeland and semi-dense and dense forests, their conversion into the lakes and reservoirs is considered a negative impact. That is why land use change is predicted as a negative, definite, permanent, and irreversible impact with moderate intensity.

*Migration to the area:* With regard to the need for skilled and unskilled manpower to build the dam and power plant, migration to the area is inevitable. Thus, it is regarded as a possible impact with an uncertain and temporary outcome that indirectly occurs in the constructional phase within a short term.

*Prevention of outward migration:* As has already been mentioned, the study area is a migrant transmitter region due to prevailing socioeconomic conditions, including high unemployment, low incomes, and lack of appropriate facilities, etc. It is predicted that the manpower required for building dams and power plants, installation equipment, and other constructional affairs creates plenty of jobs and prevents migration to the surrounding cities. Therefore, prevention of outward migration is a possible temporary impact, which is indirectly gained in the short term.

*Impact on cultural environment:* by studying the affected environment to prepare an impact assessment matrix as well as analyze the obtained data by means of SPSS Software, it was concluded that the constructional phase imposes adverse impacts on the cultural environment. Among the adverse impacts, we can point to impacts on landscapes and scenery due to holding workshops and construction in the site. On the other hand, the entrance of lots of laborers, including official staff and workers, can cause a long-term impact on the cultural characteristics in the region. Moreover, the sudden arrival of a large population of migrants into the study area adversely affects facilities, services, and even health indices.

*Transportation and traffic:* According to professional evaluations, the project imposes a 100 percent negative impact on transportation and traffic within the constructional phase. The impacts occur as a result of personnel transportation as well as transit of heavy vehicles required for various building activities such as excavation, embankment, and transportation of materials.

*Real estate prices:* The starting constructional phase is followed by a 50 percent increase in property prices as a result of future development. Such an impact will occur in the long term.

*Waste disposal:* The project has a negative, medium, and short-term impact on waste disposal due to the production of solid waste and effluent.

*Security:* Safety and security of the residents in the study area is affected by the entrance of non-native workers. Via filled questionnaires, the inhabitants expressed their concerns about some robberies that occurred in the villages around the project. The impact is important, definite, reversible, and temporary, with medium intensity.

*Agriculture and rangeland:* The majority of the people living throughout the dam area have service jobs. In the meantime, farming is considered the second priority job. In the construction phase, lots of farmland, along with several hectares of rangeland, are degraded. The impact is predicted to be direct, definite and reversible, which arises with medium intensity in the long term.

*Future development plan:* The construction phase of the dam will lead to the establishment of various development projects within the not-too-distant future.

## Social Impacts of the Project in the Operational Phase

*Cultural features:* In the operational phase, due to the presence of a large number of individuals for dam maintenance, there is always a need for professionals and workers. This will lead to the entrance of a different culture into the area. Therefore, it can impose a negative, direct, and permanent impact on the social environment over the long term.

*Traffic:* In the operational phase, traffic derived from the transportation of laborers, fuel, and required materials can have a negative, definitive, direct, and permanent impact over the long term.

*Residue and effluent disposal:* The disposal of the residue and effluent resulting from cleaning the sedimentation of the tanks can cause a negative and direct impact with high intensity in the long term.

*Security:* The movement of employees who come from different parts of the country somehow affects the security of the area adversely. The impact can be categorized as irreversible, indirect, and long lasting.

*Power generation (equal to 1,000 MW):* Generation of 1,000 MW of electrical energy can be classified among the most important positive, definitive, and permanent impacts of the plan.

*Creating recreational potential:* Sites considered to establish the reservoirs of Siah Bishe Dam are located on Karaj-Chalooos Road. It is one of the most important communication roads in the country. Every year, the road is visited by thousands of tourists. Within the context of prevailing landscapes, including forests, rivers, rangelands, and green plains, the study area has potential for recreational purposes. The noted potential will rise by impoundment of the reservoirs. The impact is classified as permanent and an indirect effect in the long term.

*Migration to the area and prevention of outward migration:* The plan requirements for manpower for various activities in the operational phase have the potential to increase the employment rate in the area.

Considering that the area is a migrant transmitter region, reduction of migration to the area and prevention of outward migration is regarded as a possible, positive, permanent and indirect impact. It affects the region and adjacent areas over the long term.

*Overwhelm rangelands within the reservoir area:* By impoundment of the reservoirs, approximately 52 ha of entire forests and rangelands will be flooded. Regarding current land use, lack of agricultural lands and low area of the drown areas, the impact is predicted to occur with medium intensity. It is a permanent, direct, and uncontrolled impact. Considering the project implementation status and the incoming immigrants, the impact on residents' health is predicted as uncertain. Since the study area is a cold region, the incidence of water-born disease is not expected.

*Job creation:* Considering residents' requirements to provide a livelihood, the creation of employment opportunities at the operational phase is predicted as positive.

*Possibility of development:* By establishing the plant and dam, the increase in recreational potentiality, attraction of labor forces, and expertise in the area, an increase in incomes and living standards alongside, the possibility of other induced developments in the area are regarded as uncertain, possible, permanent, and indirect impacts occurring with low intensity in the study area.

*Impact on infrastructure facilities and services:* By establishment of the plant and dam, the need for infrastructure facilities and services is increased to facilitate the constructional and operational affairs. Providing more infrastructure facilities is regarded as an indirect, positive impact occurring over the long-term.

*The drowning risk:* Due to the touristic nature of the study area, drowning risk threatens those who are swimming in the lake. The impact is regarded as negative, permanent, and direct which occurs with high intensity in the short term. It is an irreversible but preventable and manageable impact. The impact can also be revealed as the risk of falling vehicles into the reservoirs.

*Flooding Karaj-Chaloos Communication Road:* Implementation of the project is followed by flooding 6.5 km of the Karaj-Chaloos Road adjacent to the upstream reservoir.

*Land use changes:* The change of land use; forest and rangeland into the lake is considered a negative and irreversible impact. Regarding the small area that is subject to flooding, as well as the low density land cover surrounding the lake, it is predicted that the impact will occur with low intensity.

Total amount of positive and negative impacts within construction and operational phases are demonstrated in Figs. 2 and 3 (a and b).

## Conclusion

Optimal and sustainable use of available water resources enjoys a special position in the development programs of Iran. Meanwhile, a reliable water supply for agri-

cultural lands where there are high potentials for crop production or generation of hydroelectric power has always been considered in macro-economic development programs in Iran. Construction and operation of each development project, besides the undeniable positive effects, is coupled with adverse consequences on social characteristics of affected communities. Thus, it is necessary to conduct studies to find out appropriate strategies for dealing with the issue. The present study, by performing several field studies, offers different strategies and options to mitigate adverse socio-cultural impacts of the project in the form of an executive plan. The most important point to note here is that a significant portion of the identified impacts and outcomes can be controlled and managed by mitigation measures. Considering the noted issue, it should be concluded that the positive impacts of the project have a preference over the negative consequences. After analyzing the questionnaires and matrices using SPSS software, it was revealed that temporary impacts are mainly related to the construction phase, of which 33.7% is positive and the rest negative. Around 80% out of total permanent impacts is positive while the rest is negative. The value clearly indicates the dominance of permanent and long-term positive impacts over the negative long-term consequences. In addition to these cases, among the important consequences of the project none of them belongs to the adverse impacts. In other words, all high-intensity outcomes of the project are positive. With consideration to this issue, it should be stated that due to the significant superiority of the positive consequences over the negative impacts, the project is permitted from the standpoint of the environment.

Regarding the impacts predicted for various steps of the project using the Monavari 2001 method, some mitigation strategies were presented in the form of a management and monitoring plan. Table 3 gives general methods to manage and monitor economic and social outcomes derived from establishment of the Siah Bishe Dam.

It is worth noting that there are lots of methods to assess social impacts derived from development projects. Each in turn has its own advantages and disadvantages.

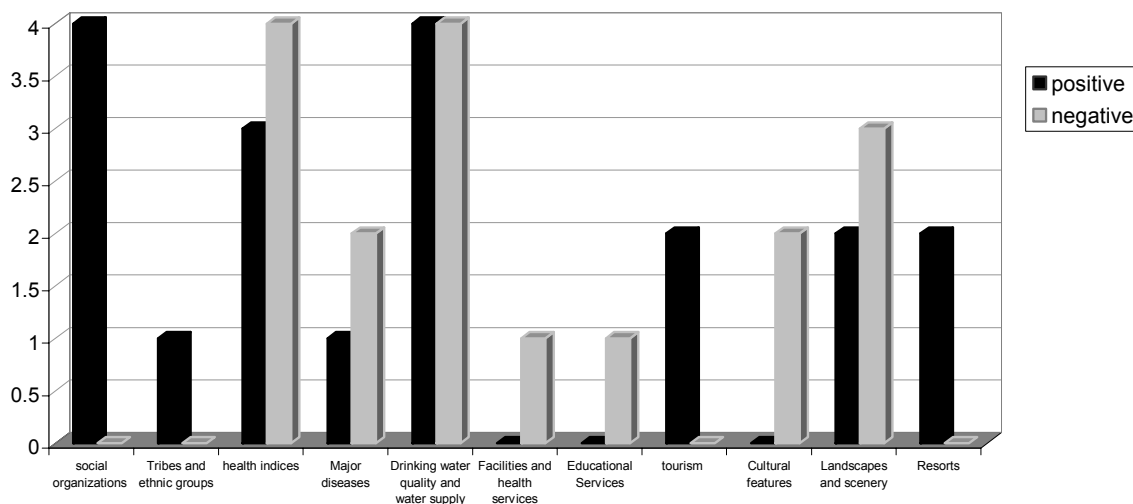


Fig. 2. Comparison of positive and negative impacts on the cultural environment through the construction and operational phases.

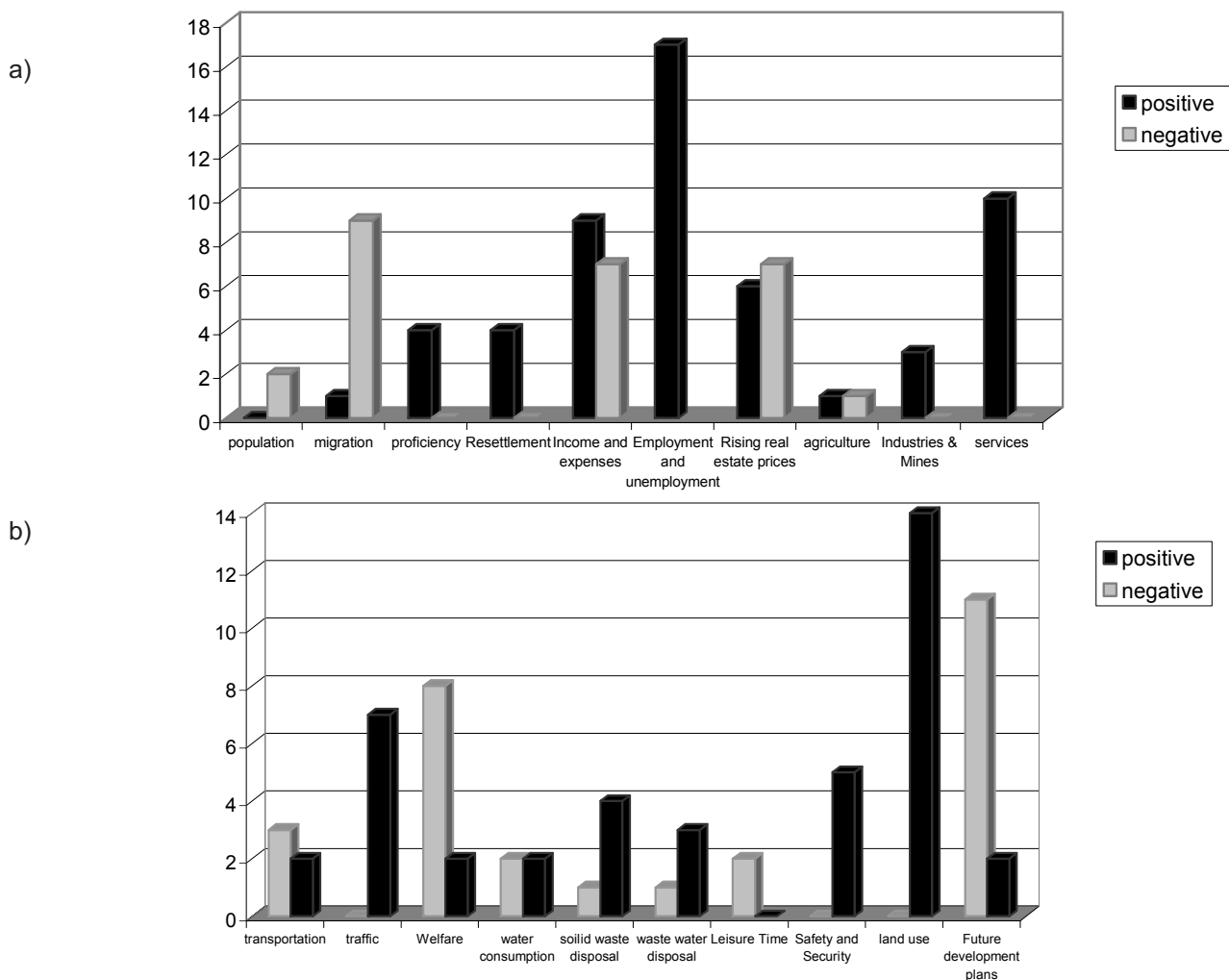


Fig. 3. Comparison of positive and negative impacts on socioeconomic environment through constructional and operational phases (a and b).

In the meantime, the Monavari 2001 method can be introduced as an appropriate method. Study ahead shows how useful the method is in handling the SIA studies. The method is structured by participatory-based matrices that offer a fuzzy range to measure intensity of the consequences.

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