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# Management Responses for Chehel-Chay Watershed Health Improvement Using the DPSIR Framework

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## ABSTRACT

**Awareness of watershed problems and their consequences based on causal models is a fundamental step in the implementation of integrated watershed management plans and achieving watershed health. In this study, the DPSIR framework was used to analyze watershed health and cause-effect relations among its components, as well as structuring information in the Chehel-Chay Watershed, Golestan Province, Iran. For this purpose, first, items of each component were identified by library studies and literature reviews, and also discussion with NGOs and members of the village council. The validity and reliability of the questionnaire were confirmed by, respectively, a group of experts and Cronbach's alpha method. The sample size of the watershed residents was calculated by Cochran's formula. Then, the items were prioritized using the Friedman test based on the Likert scale, from the viewpoints of 28 experts and 94 residents. The matrix of relations between the items of the main components and their prioritization was determined according to the perspective of both groups. The results showed that the compliance rate of common priorities among 40% of the top priorities was 73% for the component of Pressure, 60% for the components of State and Impact, and 58% for the component of Response. Also, the most important managerial responses were identified and prioritized. Due to the presence of various stakeholders, applying these responses in the framework of integrated watershed management is crucial to improve watershed health.**

**Keywords:** Causal framework, Driving forces, Integrated watershed management, Reactive and proactive approaches.



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## ITRODUCTION

Unsustainable development is a threat to different types of ecosystems. This issue is becoming more acute in developing countries because new technologies are used without caution and there is no integrated approach to examine all relevant aspects (Sadoddin *et al*., 2016). The half-century of unsustainable development in Iran has damaged the natural system of watersheds (Mosaffaie, 2019). The high rates of soil erosion and dust events, the severe drop of groundwater level and land subsidence, widespread land degradation, as well as destructive floods are the evidence for the lack of health of the watersheds in Iran (Motagh *et al*., 2008; Khormali and Nabiollahi, 2009; Malekinezhad *et al*., 2011; Mahmoudpour *et al*., 2013; Mosaffaie, 2015; Sadeghi, 2017; Salehpour Jam *et al*., 2017; Asadi *et al*., 2018; Roudgarmi and Farahani, 2017). In this regard, the study area, Chehel Chay Watershed, also has problems such as high rates of soil erosion and landslides, flood, and environmental pollution (Mousavi Nezhad *et al.*, 2017; Karimi Sangchini *et al.*, 2013).

Watershed health is used as an extension of the concept of ecosystem or ecological health at the watershed scale (Flotemersch *et al*., 2016). Watershed health also refers to the maintenance of the "normal" state of such a complex adaptive system (Mosaffaie *et al*., 2020). In this study, the watershed health is considered in the Chehel Chay

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Watershed, especially with the emphasis on the aspects of erosion and sediment, flood, and the quantity and quality of soil and water resources and their adverse effects have been investigated by causal relations. Considering the importance of an integrated management approach in the sustainable development of Iran watersheds, the National Mega-Project of the Integrated Watershed Management was approved by the Committee on Agriculture, Water, and Natural Resources of the Supreme Council of Sciences, Research, and Technology (Sadoddin *et al*., 2016). This article is the result of the first step of this Mega-project entitled "System Analysis and Identification of Problems using the DPSIR Framework" in Chehel Chay Watershed.

## MATERIALS AND METHODS

### Theoretical Framework of the Research

The Driver-Pressure-State-Impact-Response (DPSIR) framework was introduced by the European Environmental Agency in the 1990s (EEA, 1995) to study the environmental problems and find responses to improve social-ecological systems (Carr *et al*., 2007; Gari *et al*., 2015; Baldwin *et al*., 2016). Using the DPSIR approach, it is possible to identify appropriate managerial responses by identifying cause and effect relations among its components, as well as structuring information. In other words, the driving forces and pressures cause environmental problems in the watershed. This state causes negative socio-environmental impacts in the watershed. In this regard, each component of the model has its responses to improve watershed health. In the process of evolving this approach, first, Stress-Response (SR) framework was developed by Canada's national statistical agency in 1979 (Friend and Rapport, 1991), then, Pressure-State-Response (PSR) framework was used by the OECD in 1993 (OECD, 1993), and finally, the DPSIR framework was introduced by the EAA in 1995 and has been used in the Dobris assessment in Europe (EEA, 1995).

The main components of the DPSIR framework are presented in Figure 1. The logical action in implementing this model begins with identifying the existing state and then identifying and introducing the direct factors (pressure) and indirect factors (driving forces) that trigger the current state. Also, responses can be identified for other components of the model.

So far, the watershed health assessment has been conducted using different methods. For example, it has been assessed using the Soil and Water Assessment Tool (SWAT) (Ahn and Kim, 2019; Jabbar and Grote, 2020), Multi-Criteria Decision Making (MCDM) models (Alilou *et al*., 2019), and causal frameworks such as the pressure–state–response, PSR (Mao *et al*., 2014; Sun *et al*., 2019; Hazbavi *et al*., 2020), and DPSIR (Zou and Wu, 2011; Mosaffaie *et al*., 2020). In this regard, The causal framework has been used and modified by various researchers for assessment of watershed health, for example, SR (Friend and Rapport, 1991), PSR (OECD, 1993), DPSIR (EEA, 1995), mDPSIR (ELME, 2007), DPSWR (Cooper, 2013), and DPSER (Kelble *et al*., 2013). The DPSIR framework, with several appreciations and criticisms, is still a useful adaptive management tool for identifying solutions to environmental problems, but its success needs a democratic atmosphere, political will, and clear governance (Gari *et al*., 2015). The framework has also been widely used over the past decade (Kagalou *et al.*, 2012; Alves *et al.*, 2013; Celliers *et al.*, 2015; Zebardast *et al.*, 2015; Goble *et al.*,

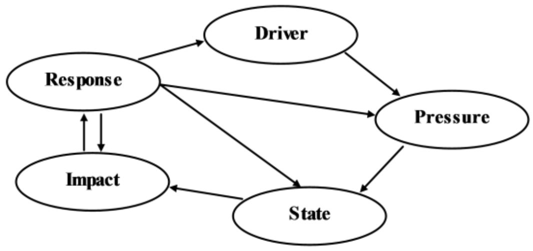


**Figure 1**. Components of the DPSIR framework.

2017; Gari *et al*., 2018; Kazuva *et al*., 2018; Sheikh *et al*., 2020).

Despite various watershed management measures in the Chehel-Chay Watershed, its health situation is still unfavorable (Mousavi Nezhad *et al*., 2017; Karimi Sangchini *et al.*, 2013). In this regard, the lack of causal frameworks in watershed management studies causes managerial responses to be more focused on the current state and less attention to the drivers and pressures. To improve the health of this watershed, it is necessary to have proper management responses for drivers and pressures, state and related impacts on the scale of the watershed. In this regard, identifying causal factors of watershed health and impacts of the current state are crucial.

The current study is related to the first step of the National Mega-Project of the Integrated Watershed Management under the title of "System analysis and identification of problems using the DPSIR framework" in Chehel Chay Watershed and has been introduced as a new approach in watershed management studies.

This study aimed to: (1) Identification of the causal factors of the watershed health in the Chehel-Chay watershed using the cause and effect framework of DPSIR, as well as identification of the responses to improve the state and reduce related adverse impacts, and (2) Prioritization of the causal items of the DPSIR components using the nonparametric test and Friedman test, from the viewpoints of experts and watershed residents. This is the key to taking measures to remove obstacles and make decisions in integrated watershed management plans.

## Research Area

Chehel-Chay Watershed is located in the south of Minoodasht City of Golestan Province and is one of the sub-basins of Gorgan-Roud. The minimum and maximum altitudes are 180 and 2555 meters above sea level, respectively. It is located between 55° 23' 24" to 55° 38' 22" East longitude and 36° 59' 53" to 37° 14' 2" North latitude and covers an area of about 25773 ha (Figure 2). The main drainage basins collect the atmospheric precipitation with a general south-to-north direction. A large part of the area is mountainous and the source of the Chehel-Chay River is from the highlands of

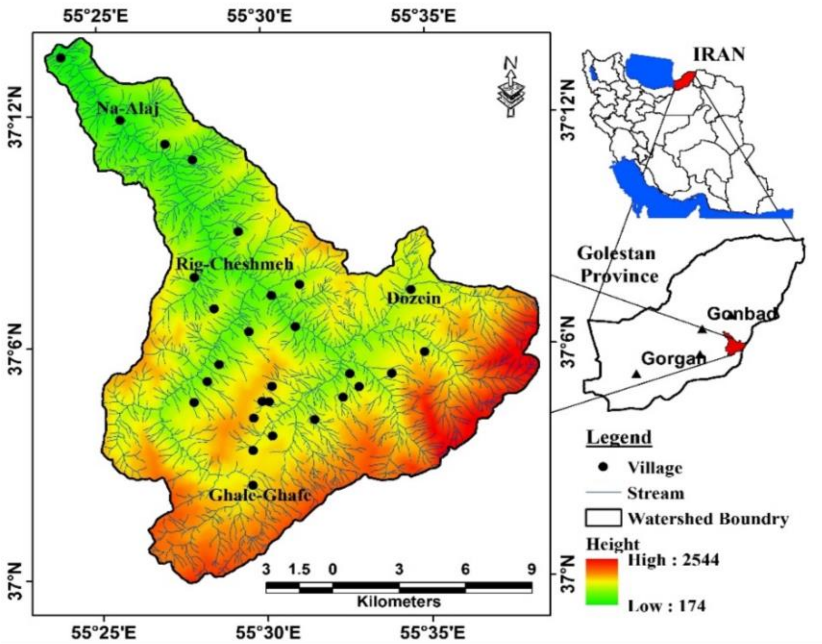


**Figure 2.** Chehel-Chay Watershed, Golestan Province, Iran.

the region. This watershed has two humid and semi-humid climates and also has two important land uses of forest and agriculture. The results of the latest census in 2017 indicate the presence of 28 villages in this watershed, which includes 3,918 rural households. In this regard, the Dozein and Na-Alaj villages with a population of 5,737 and 15 people have the maximum and minimum population of the watershed, respectively.

This watershed has problems such as high rates of soil erosion and landslides, flood, and environmental pollution (Mousavi Nezhad, 2017; Karimi Sangchini, 2013) and has been selected as a pilot watershed in the National Mega-Project of the Integrated Watershed Management.

## Identifying the Components of the DPSIR Framework

This study was descriptive-inferential and the data collection was conducted by literature reviews and interviews with experts and watershed residents. In this study, the DPSIR framework was used to analyze watershed health and cause-effect relations among its components, as well as structuring information in the Chehel-Chay Watershed. First, items of each component were identified by library studies and literature reviews, and discussions with NGOs and members of the village council (Figure 3). Finally, the validity of the questionnaire was confirmed by the expert group. One of the main challenges of this study, which lasted eight months, was the creation of brainstorms and the identification of cause and effect relations among components.

## Prioritizing Items of the DPSIR Components

To prioritize and determine the importance of the variables in each component of the DPSIR framework in the Chehel-Chay Watershed, a questionnaire (Likert scale) was used as a measurement tool. In this study, the importance of each variable was examined from the perspective of experts

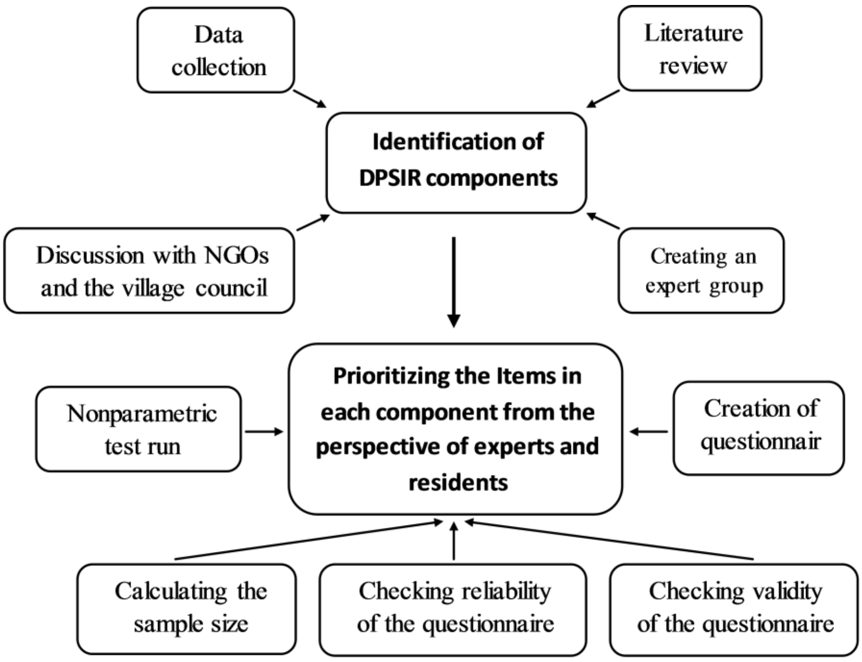


**Figure 3.** Flow chart of the study for identification and prioritization of the items of watershed health improvement.





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**Table 1.** Cronbach Alpha values.

| Questionnaire | Component | Number of items | Cronbach's alpha |
|---|---|---|---|
| Experts | Pressure | 26 | 0.803 |
| | State | 12 | 0.880 |
| | Impact | 11 | 0.829 |
| | Response | 31 | 0.703 |
| Residents | Pressure | 26 | 0.718 |
| | State | 12 | 0.702 |
| | Impact | 11 | 0.722 |
| | Response | 31 | 0.805 |

and watershed residents (Figure 3).

According to the latest census in 2017, the statistical population of this study consists of all rural households in the basin which includes 3,918 rural households. In this study, the sample unit is a rural household and the Cochran formula was used to calculate sample size (Equation 1). Based on the presence of 3,918 rural households in the watershed, 94 samples were selected based on the Cochran formula as the sample size for the resident questionnaire. A random sampling method was used for selecting the samples. The opinion of 28 experts was also considered as a large group decision-making to prioritize items (Carrascosa, 2018). The expert group consisted of experts from the Departments of Natural Resources and Watershed Management, Environment, Regional Water, and Agricultural Department, and also scientific members of Agricultural Sciences and Natural Resources of Universities of Gorgan and Gonbad, as well as NGOs and some members of the village council.

$$n = \frac{\frac{z^2pq}{d^2}}{1+\frac{1}{N}\left(\frac{z^2pq}{d^2}-1\right)} \quad (1)$$

Where, n is sample size, N is statistical population (households in the watershed), and d is the permissible error (d= 0.1); z was equal to 1.96, P and q equal to 0.5.

The questionnaire with the Likert scale [very low (1), low (2), medium (3), high (4), and very high (5)] was used as a measurement tool.

In this study, after determining the items of each component of the DPSIR, the validity of the questionnaire was confirmed by a group of experts. Also, the Cronbach's alpha method was used to calculate the reliability of the measuring instrument. The Cronbach's alpha value based on Equation 2 was calculated using SPSS software (Table 1). Given that this coefficient is greater than 0.7, the instrument of measurement (questionnaire) has high reliability and, in other words, the considered items have high internal consistency and reliability (George and Mallery, 2003).

$$\alpha = \frac{k}{k-1}\left(1-\frac{\sum_{i=1}^{k} S_i^2}{S_t^2}\right) \quad (2)$$

Where, K is the number of variables, $S_i^2$ is the variance of the score for item number j, and $S_t^2$ is the variance of each respondent's scores (the variance of the total variables).

Finally, Friedman's test was used to analyze two-way variance through ranking and also to compare the average rankings of different groups using SPSS software (Equation 3).

$$\chi^2 = \frac{12}{Nk(k+1)}\sum_{j=1}^{k} R_j^2 - 3N(k+1) \quad (3)$$

Where, K is the number of columns or questions, N is the Number of rows, and $R_j$ is the sum of the Ratings in the j column. In this case, the degree of freedom is k-1.

## RESULTS AND DISCUSSIONS

The list of available drivers and their pressures, the state and its consequences, and the necessary corrective responses are





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presented in Table 2 for improving the health of the Chehel-Chay Watershed. Also, to better understand the relations among components of the DPSIR framework, the relevance among various states in the Chehel-Chay Watershed and the effective pressures on their occurrence, as well as their impacts are illustrated in Figure 4.

Determining items of the DPSIR components and recognizing the causal relations among them has an important role in introducing the necessary technical-managerial responses for improving the watershed health (Mosaffaie *et al*., 2020). In this study, 31 responses were identified and introduced to reduce the driving forces and related pressures, improve the state, and also reduce the adverse impacts (Table 1). Responses may cover one or more items. In this regard, 22.6% (7 items), 64.5% (20 items), 22.6% (7 items) and 51.6% (16 items) of the responses cover the components of the driver, pressure, state, and impact, respectively. The feature of the DPSIR model, which is common in all of its studies, can be the presence of different responses to solve a particular item of a DPSIR component. Also, a particular response can cover multiple items of one or more components (Carr *et al*., 2007; Newton *et al*., 2014; Lalande *et al*., 2014; Khunanake *et al*., 2018). To better understand the relations among the components of the DPSIR framework, various situations in the Chehel-Chay Watershed and the effective pressures on their occurrence are also described in the following:

Environmental Pollution (S1): The pressure of p5 is one of the most important causes of S1 in the watershed, which have caused different impacts (Figure 4). R8 and R9 are the appropriate management responses.

Reducing the Quality of River Water (S2): P1, P3, P5, P6, P11, P13 and P18 are the most important causes of S2 in the watershed. Management responses are presented in Figure 5.

Also, P1 and P3 are related to climate change and no response can be provided for them on a local scale.

Reducing the Amount of River Water (S3): P1, P2, P3, P16, P17, and P20 are the most important causes of S3 in the watershed (Figure 4). In this regard, R10, R13, and R7 to solve the problem of P16, and R13 to solve the problem of P17, and finally, R25 and R14 have been introduced to solve the problem of P20.

Spring Pollution (S4): P5 is the most important cause of spring pollution in the watershed (Figure 4). The response is presented in Figure 5.

Soil Erosion and Flooding (S5 and S6): Most effective pressures on soil erosion also contribute to flooding. P1, P2, P3, P6, P8, P9, P10, P11, P13, P15, and P19 are the most important causes of soil erosion and flooding in the watershed, which have caused different impacts (Figure 4). Also, P18 is a pressure that leads to soil erosion. In this regard, management responses are presented in Figure 6 and in previous sections.

Reducing Soil Fertility (S7): P1, P3, P6, P8, P11, P12, P13, P14, P19, and P20 are the most important causes of reducing soil fertility in the watershed which have caused different impacts (Figure 4). In this regard, R7, R15, and R16 to solve the problem of P12; and R7, R13, and R14 have been introduced to solve the problem of P14. Other responses to pressures are presented in the previous sections.

Disturbing the River Regime and Freezing Stress (S8 and S9): P3 and P15 are the most important causes of S8 in the watershed which have caused different impacts. Also, P2 leads to the S9 in the Chehel-Chay Watershed (Figure 4). The related responses of each pressure are presented in the previous sections.

Reducing Spring Discharge (S10): Spring discharge plays an important role in the sustainability of their dependent businesses and livelihoods of residents. P1, P2, and P3 are the most important causes of S10 in the watershed, which have caused different





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**Table 2.** Components of DPSIR framework for Chehel-Chay Watershed health Improvement.

| | |
|---|---|
| Driver | Employment (agriculture, Ranching, etc.) (D1), Climate change (D2), Population growth (D3), Land laws (D4), Management and organization (D5), Civil measures (D6) |
| Pressure | Reducing rainfall (P1); Extreme thermal changes (P2); Change the rainfall distribution time (P3); Change the type of precipitation (P4); Domestic waste and sewage production (P5); Fire (P6); Wood smuggling (P7); Consumption of watershed resources (P8); Fuel consumption (P9); Cutting the branches (P10); Overstocking (P11); Grazing livestock in the forest (P12); Plow in the direction of the slope (P13); Cultivation on sloping lands without agricultural potential (P14); Over-harvesting of river-sand aggregates (P15); Overuse of water resources in the agricultural sector (P16); High water demand for agricultural products (P17); Dumping construction debris on the side of the road (P18); Improper land-use change (P19); Establishing gardens in sloping lands without suitability (P20); Land grabbing (P21); Flawed implementation of participation-based integrated watershed management projects (P22); Parallel works (P23); Lack of coherence within the organization (P24); Lack of coherence with the outside organization (P25); Ignoring Effective barriers to realizing people participation in the implementation of watershed management plans and programs (P26) |
| State | Environmental pollution (S1); Reducing the quality of river water (S2); Reducing the amount of river water (S3); Spring pollution (S4); Soil erosion (S5); Flooding (S6); Reducing soil fertility (S7); Disturbing the river regime (S8); Freezing stress (S9); Reducing spring discharge (S10) Land violations (S11); Reducing the level of public trust (S12) |
| Impact | Reducing the useful life of the dam (I1); Damage to lands and installations (I2); Increasing production costs (I3); Increasing living expenses (I4); Reducing residents' income (I5); Health Problems (I6); Reduction of food security (I7); Increasing migration from village to city (I8); Decreasing forage yield and grazing capacity (I9); Reduction of national land (I10); Less success of projects (I11) |
| Response | Designing a fire alarm and extinguishing system (R1); Improving the living standards of foresters, both economic and social (R2); Physical protection of the watershed to prevent wood smuggling and other violations (R3); Technical protection of the watershed and observance of the principles of sustainable forest management (R4); Water and soil conservation practices (R5) Flood risk control practices (R6); Job creation and alternative livelihoods (R7); Promoting culture to reduce risks (R8); Household waste and sewage Management (R9); Promoting culture for optimal resource consumption (R10); Compliance with the water rights of downstream is based on Gorgan Roud Water Resources Management programs (R11); Supervision of road construction operations (R12); Education and extension in agriculture (R13); Ecological Capacity Assessment and Land use planning (R14); Exiting the livestock from the forest (R15); Reviewing grazing permissions (R16); Principle exploitation of river sand resources (R17); Monitoring the harvesting of river sand resources (R18); Adapting to water scarcity (irrigation pattern correction, crop pattern correction, correction of water consumption pattern, etc.) (R19); Identifying and planting frost proof species compatible with the region (R20); Supportive packages (R21); The development of rainwater harvesting systems based on the water rights of downstream (R22); Designing a monitoring system and drought warning (R23);Completing the cadastre (R24) Modifying the laws (R25); Creation of integrated watershed Management Coordination Committees in the watershed (R26); Implementation of all natural resources projects in the form of programs derived from the integrated watershed management approach (R27) ; Creating NGOs based on integrated watershed management plans and objectives (R28); Prioritizing and eliminating factors affecting non-participation in implementing watershed management plans and programs (R29);Insurance services (R30); Practices to reduce the vulnerability to flood (R31) |



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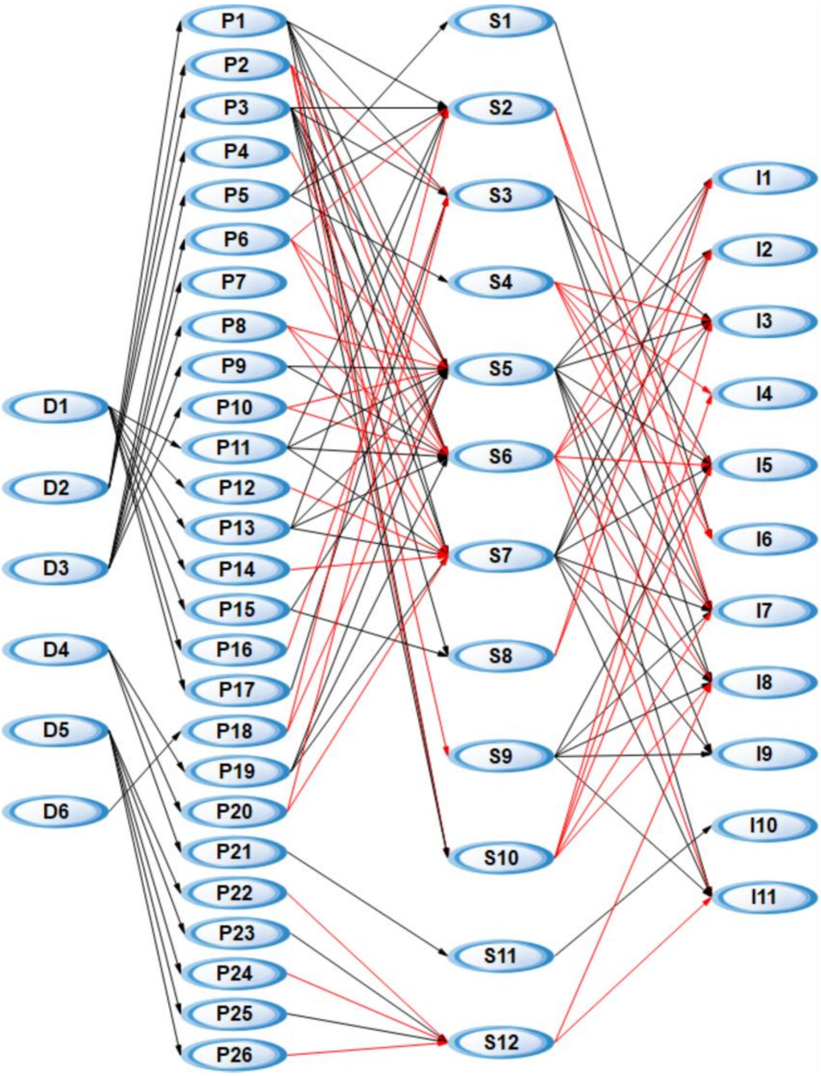


**Figure 4.** Causal relations among different components of the DPSIR framework in the Chehel-Chay Watershed.

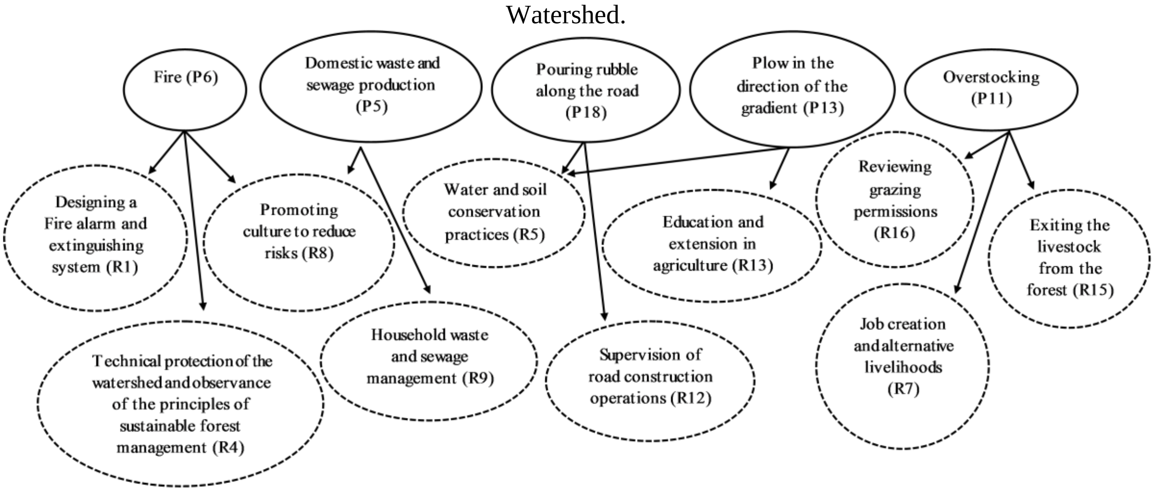


**Figure 5.** Management responses to solve the problem of “reducing the quality of river water”.





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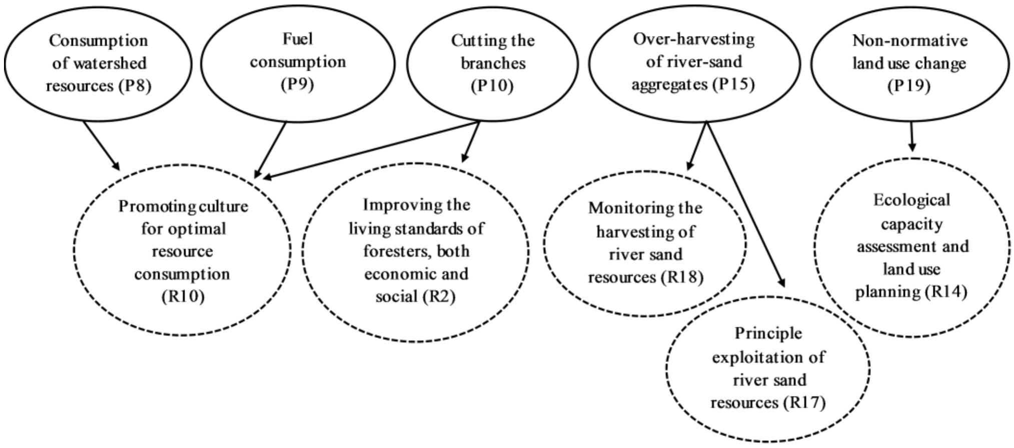


**Figure 6.** Some management responses to solve the problem of "soil erosion and flooding".

impacts (Figure 4). The related responses of each pressure are presented in the previous sections.

Land Violations (S11): P21 is the most important cause of S11 in the watershed, which has caused the land tenure. Therefore, completing the cadastre project is the appropriate management response to reduce land grabbing.

Reducing the Level of Public Trust (S12): P22, P23, P24, P25, and P26 are the most important causes of S12 in the watershed, which has caused less success of the projects. In this regard, management responses are presented in Figure 7 and in previous sections.

Friedman's test results of the questionnaires completed by residents and experts are summarized in Table 3 and presented in Figures 8 and 9.

In this study, to know about the common perspective of experts and residents, the frequency of the presence of the same items in the prioritization was investigated among the 40 percent of the top priorities. The results of the study showed that the presence of the same items in the prioritization was 73% (8 items) for the component of pressure, 60% (3 items) for the component of state and impact, and 58% (7 items) for the component of the response (Table 4). The presence of agreed items among experts and residents in 40% of the top priorities can be a reason for better participation of people in the implementation of programs, especially about agreed items. Also, identification and prioritization of effective factors for people's participation in the

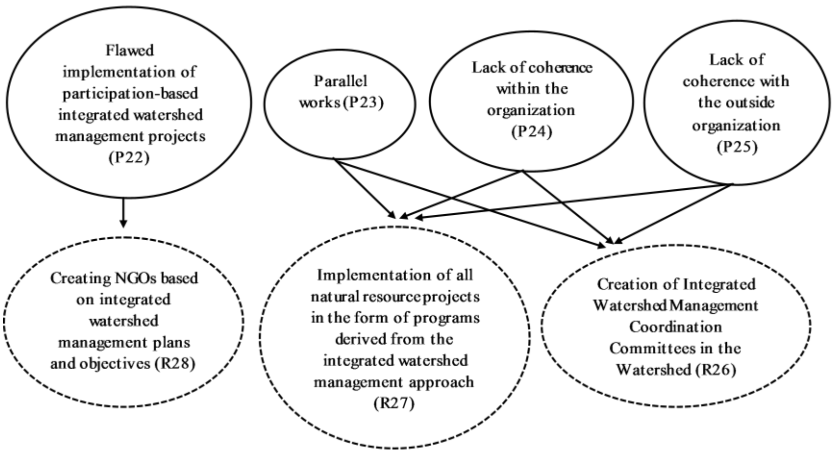


**Figure 7.** Management responses to solve the problem of "reducing the level of public trust".

**Table 3.** Friedman's test results for items of the DPSIR components from the viewpoint of experts and residents.[a]

| Component | Questionnaire | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Experts | | | | | | Residents | | | | | |
| | Item, Min MR | Item, Max MR | N | Chi-square | DF. | Asymp sig | Item, Min MR | Item, Max MR | N | Chi-square | DF. | Asymp sig |
| Pressure | P9,6.19 | P14,21.31 | 28 | 78.266 | 25 | 0.00 | P10,3.73 | P5,23.36 | 94 | 1123.145 | 25 | 0.00 |
| State | S9,2.65 | S3,9.00 | | 45.099 | 11 | | S4,2.18 | S10,10.59 | | 523.954 | 11 | |
| Impact | I10,4.82 | I11,7.14 | | 13.778 | 10 | | I6,2.41 | I8,10.45 | | 421.612 | 10 | |
| Response | R16,8.15 | R14,20.65 | | 73.723 | 30 | | R17,3.08 | R9,21.95 | | 1133.498 | 30 | |

[a] N= Number of questionnaires, DF= Degree of Freedom, Sig= Significance, MR= Mean Rank.

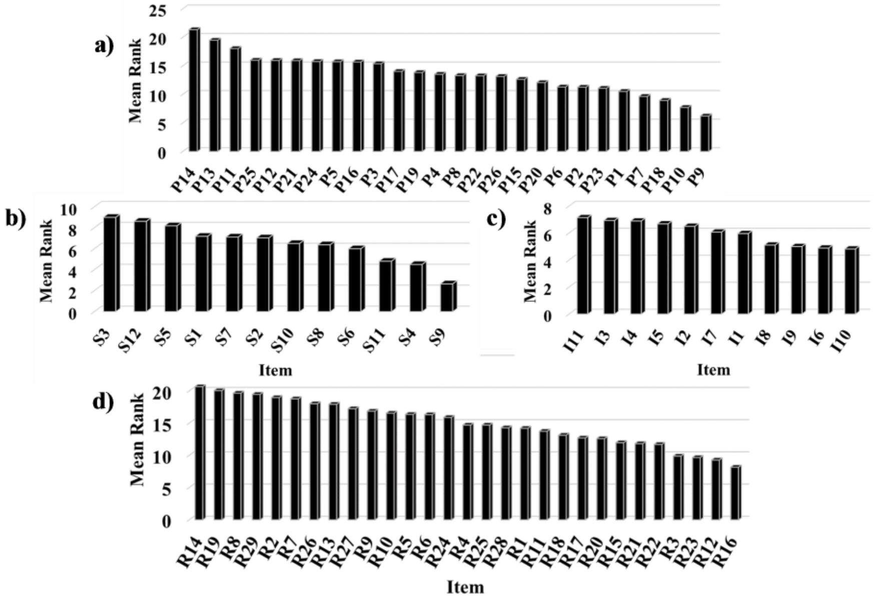


**Figure 8.** Prioritization of the items for different components of the DPSIR framework from the viewpoint of experts (a= Pressure, b= State, c= Impact, and d= response).

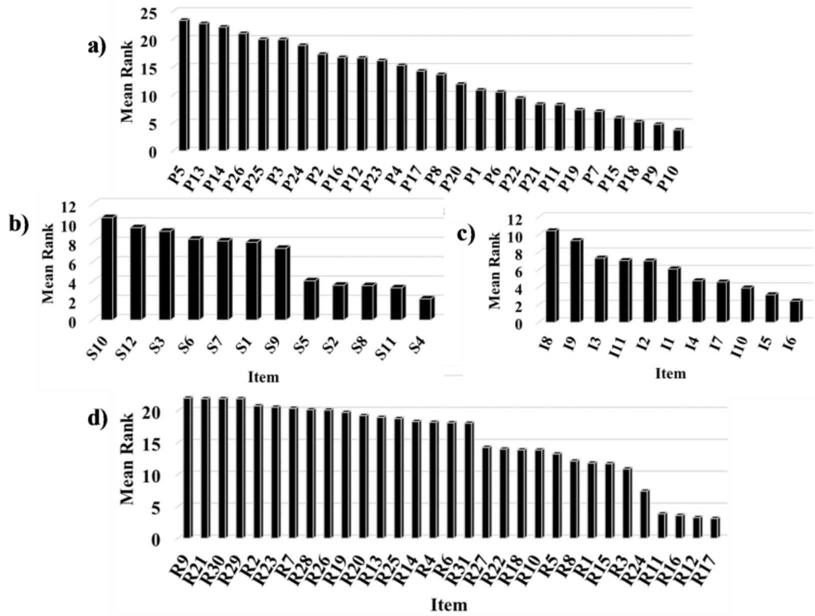


**Figure 9.** Prioritization of the items for different components of the DPSIR framework from the viewpoint of residents (a= Pressure, b= State, c= Impact, and d= Response).





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**Table 4.** The most important items from the perspective of both groups among the 40 percent of the top priorities.

| | |
|---|---|
| Pressure | Change the rainfall distribution time (P3); Domestic waste and sewage production (P5); Grazing livestock in the forest (P12); Plow in the direction of the gradient (P13); Cultivation on sloping lands without agricultural potential (P14); Overuse of water resources in the agricultural sector (P16); Lack of coherence within the organization (P24); Lack of coherence with the outside organization (P25 |
| State | Reducing the amount of river water (S3); Reducing soil fertility (S7); Reducing the level of public trust (S12) |
| Impact | Damage to lands and installations (I2); Increasing production costs (I3); Less success of projects (I11) |
| Response | Improving the living standards of foresters, both economic and social (R2); Job creation and alternative livelihoods (R7); Household waste and sewage management (R9); Education and extension in agriculture (R13); Adapting to water scarcity (irrigation pattern correction, crop pattern correction, pattern correction of water consumption, etc.) (R19); Creation of integrated watershed management coordination committees in the watershed (R26); Prioritizing and eliminating factors affecting non-participation in implementing watershed management Plans and programs (R29) |

implementation of watershed management projects is very crucial (Salehpour Jam, 2018).

Due to the presence of various responses to improve watershed health and reduce the adverse impacts of the current state, it is necessary to pay attention to the following points: (I) The responses cover all components of the driving forces, pressures, state, and impacts. In this regard, determining the appropriate response for each of these components is one of the important features of the DPSIR framework (EEA, 1995; EEA, 1999); (II) The responses cover a variety of watershed stakeholders. In this regard, technical-managerial responses should be implemented in the context of integrated watershed management (Sadoddin *et al*, 2016; Mosaffaie *et al*., 2019); (III) It is necessary to pay attention to both proactive and reactive approaches in designing and implementing responses. Simultaneous attention to these two approaches has been emphasized in environmental management (Kim, 2018; Sikdar, 2019).

## CONCLUSIONS

Identification of driving forces and their pressures, studying the status of the watershed and relevant impacts, as well as determining the necessary responses were performed according to the cause and effect framework of the DPSIR to improve watershed health. Also, items of the DPSIR components were prioritized from the perspective of experts and residents. In this regard, the DPSIR model provided an appropriate framework with logical relations to improve watershed health.

The results also showed that employment (agriculture, ranching, etc.), climate change, population growth, land laws, and, finally, management and organization were the most important driving forces affecting the health of the Chehel-Chay Watershed.

Given that in determining the responses, all components including the driving forces and related pressures as well as the components of the current state of the watershed health and related impacts have been considered, it is necessary to pay attention to both reactive and proactive approaches. Also, given that the responses involve a wide range of stakeholders, their implementation in the framework of integrated watershed management has been emphasized.

In this study, various responses were prioritized to improve the watershed health from the perspective of experts and



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watershed residents. In this regard, improving the living standards of foresters, pay attention to alternative livelihoods, household waste and sewage management, education and extension in agriculture, adapting to water scarcity, creation of coordination committees for integrated watershed management, and developing participatory watershed management are recommended to policymakers and administrators as the most important common responses of both groups. It is also recommended to conduct similar studies in other watersheds to better understand the relations among the DPSIR components.

One of the challenges of implementing the DPSIR framework in this study was to identify causal relations and locate them in terms of driving forces, pressure, state, and impact. This issue has been emphasized by EEA (1999). However, this framework is well able to provide management responses based on its multi-disciplinary and holistic nature and can be used in the integrated watershed management process. Gari *et al*. (2015) reviewed the application of this framework and emphasized the great appreciation of researchers in applying this framework.

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**پاسخ‌های مدیریتی بهبود سلامت آبخیز چهل چای با کاربرد چارچوبDPSIR**

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## چکیده

آگاهی از مشکلات آبخیز و پیامدهای آن در قالب مدل‌های علت و معلولی، گامی اصولی در اجرای طرح‌های مدیریت جامع حوزه‌های آبخیز و دستیابی به سلامت آبخیز است. در این تحقیق، چارچوب DPSIR به منظور تحلیل سلامت حوضه و روابط علت و علولی میان مولفه‌های آن، و نیز ساختاربندی اطلاعات حوزه آبخیز چهل چای مورد استفاده قرار گرفت. بدین منظور، ابتدا، عوامل هر یک از مولفه‌ها از طریق مطالعات کتابخانه‌ای و بررسی منابع، ایجاد کارگروه خبرگان و در نهایت گفتگو با نمایندگان سازمان های مردم نهاد و اعضای شورای روستا شناسایی شد. همچنین، روایی پرسش‌نامه به تایید خبرگان رسید و پایایی آن از طریق روش آلفای کرونباخ مورد تایید قرار گرفت. حجم نمونه ساکنان آبخیز توسط فرمول کوکران محاسبه شد. سپس، اولویت بندی موارد از دیدگاه خبرگان و نیز ساکنان محلی با کاربرد آزمون‌های ناپارامتریک آماری (آزمون فریدمن) بر اساس روش کدگذاری چند پاسخی (مقیاس لیکرت) و نظرسنجی از ۲۸ کارشناس به عنوان گروه خبرگان و نیز ۹۴ نفر از ساکنان محلی انجام شد. در این ارتباط، ماتریس روابط میان عوامل هر یک از مولفه‌های اصلی مدل و اولویت-بندی آنها از هر دو دیدگاه کارشناسان و ساکنان محلی به انجام رسید. نتایج تحقیق نشان داد که میزان تطابق اولویت های مشترک در میان ۴۰ درصد از مهمترین اولویت‌ها به صورت ۷۳ درصد برای مولفه فشار، ۶۰ درصد برای مولفه وضعیت، ۶۰ درصد برای مولفه اثر و ۵۸ درصد برای مولفه پاسخ است. همچنین، مهم‌ترین پاسخ‌های مدیریتی، شناسایی و اولویت‌بندی گردیدند. به دلیل حضور ذینفعان مختلف، کاربست این پاسخ ها در چارچوب مدیریت جامع حوزه آبخیز به منظور بهبود سلامت آبخیز ضروری است.



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