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An Introduction to Improvement of Environmental Impact Assessment Methods in Iran

[1]Iman Momeni, [2]Abdolrassoul Salman Mahini and [1]Sahebeh Karimi

[1]Department of Environmental Science,
Faculty of Natural Resources, University of Tehran, Iran
[2]Department of Environmental Sciences, College of Fisheries and Environmental Sciences,
Gorgan University of Agricultural Sciences and Natural Resources, Gorgan, Golestan, Iran

Abstract: Environmental researchers in Iran have encountered serious and new challenges about the methods that responding to research demands for development, because of the rapid economic and social development of Iran during the last decades. On one side, traditional methods of environmental impact assessment have been criticized severely by specialists. On the other hand, theoretical bases and practical conditions for executing new methods of environmental impact assessment are not available in Iran. In this situation, development of useful concepts and methods of environmental impact assessment is necessary more than the past. Furthermore, the reaction of specialists to this need has varied between being complicated and simplified. This paper indicates that improvement of environmental impact assessment methods is achievable, with assist of the basic concepts on ecology and the sciences which are related to it. In addition, authors believe that determining the status and revising current methods of environmental impact assessment will be helpful to recognize the development rate of this science. To indicate these two mentioned points, with help of concepts in ecology and Philosophy science, this paper is going over both new and traditional methods of environmental impact assessment. Then, a case study in the Golestan province(in Iran) has paved the way for criticizing and testing some concepts of new and traditional methods of environmental impact assessment in Iran.

Key words: Environmental impact assessment · Traditional methods · Modern methods · Golestan province

INTRODUCTION

Development, classification, reviewing, evaluating and criticizing scientific methods are things that interdisciplinary teams of researchers in the entire world are always worried about them. Environmental impact assessment as a branch of science is one of them. According to a definition, environmental impact assessment is a group work in which specialists of natural resources, economy and social sciences study on the positive and negative impact of development plans before setting up, during the project, when it's running and after finishing them, in order to minimize or avoid negative impacts with help from giving suggestions [1].

The range of evaluating and criticizing scientific methods varies between basic and general concepts of each branch of science. This is the same for environmental impact assessment. For instance, Shopley and Fuggle reviewed the methods of environmental impact assessment [2]. They classify all the assessment methods in 8 groups and check their weaknesses and powers. As Shopley and Fuggle say, these 8 groups are Ad Hoc, Checklist, Matrix, Networks, Map Overlay, Modeling, Evaluation and Adaptive methods. It is worth to saying these methods are still the same as the past, except mathematical and statistical basis of them. In addition, these mentioned methods need more information as they become more scientific and complicated. Specialists think about this subject that whether all the environmental impacts from ecological, economical and social aspects are meaningful or not. In 1986, Duinker and Beanlands studied on the concept of impacts meaningfulness [3] . Then in 1988, Thompson counted 24 ways for ascertaining of impacts meaningfulness [4]. He also explained each of these ways. In addition, the need for merging the results of biological, social and

Corresponding Author: Iman Momeni, Department of Environmental science, Faculty of Natural Resources, University of Tehran, Iran, Tel: +98-9133014051, E-mail: momeni.iman@gmail.com.

economical impacts is another subject that is not raised up to now. For instance, Hobbs studied viewpoints which were related to this subject and suggested solutions. In 1998, Bojorquez-Tapia *et al*. discussed to use mathematical techniques in order to improvement of environmental impact assessment [5]. non-parametric statistics such as Bayesian theory [6], Fuzzy logic like what Bojorquez-Tapia *et al*. did in 2002 and Silvert in 1997, Neural Networks like Spitz and Lek studies in 1999 are examples which are included to concepts and methods of environmental impact assessment in recent years, in order to make them more practical, acceptable and clear. In another great deal of effort, Mahiny presented comprehensive indexes for rapid environmental impact assessment, in hope of acceptable assessments when assessor don't have enough time to assessment. On the other hand in mentioned paper, geographical information system and remote sensing are defined as basis for rapid environmental impact assessment, in order to identity and repeatability of methods.

Comparative studies is another aspect of efforts to improve the environmental impact assessment methods in recent years. For instance, Ahmad and Wood made a comprehensive study on environmental impact assessment systems in Egypt, Turkey and Tunisia in 2002 [7]. In addition, the methods of decision making, Screening and scoping of environmental impacts assessment have been studied and considered comprehensively in England by Weston in 2000 [8]. Merging the methods of environmental impact assessment in Expert System Tools [9] and Decision Support Systems are up to date subjects which are under discussion. Daini used statistical methods to study the environmental impact assessment and strategic impact assessment comprehensively in 2002 [10]. In 2001, Fujikura and Nakayama with a case study,considered the causes of failing the environmental impact assessment in Canada [11]. Then, they imply to poor judgment of experts and their excessive simplify. In 1998, Warnken and Bukley reviewed the scientific basis of environmental impact assessment of tourism in Australia [12]. They indicate that the scientific basis of these assessments generally is low, because of: lack of using testable, quantitative and repeatable predictions; not involving in the impacts which are significant; using subjective and personal assessments and so on.

However these mentioned studies seem to be scattered at the first sight, all of them have at least two things that are same. First, they all try to make the environmental impact assessment more scientific and objective. Second, all these efforts are taken to make the environmental impact assessment more practical and realistic. Specialists use mathematical bases, ecology and the philosophy science, in order to make the methods of environmental impact assessment more scientific. For example, from a philosophy science point of view with an objectivity base, each scientific approach should be systematic, replicable, well-documented and clear. Based on statistics, they also give approximate same answers to repeated quantities in a special domain. Besides, the results of them should be transferable for other groups and the concepts which are used in them should be standard and understandable in all over the world. The Information Technology is used as a favored subject most of the time to makes the environmental impact assessment more practical and objective. The instances of these efforts are the Geographical Information Systems (GIS) and Remote sensing (RS) which are so expanded with help from personal computers and satellite information.

Generally in Iran, experts use Checklist and Matrix methods for environmental impact assessment, because of the time limitation and common tendencies. these two methods are subjective and the results of them are based on personal experiences, depended on place and time and not replicable. So it's possible that two assessors with different mentalities and personal experiences achieve different results from one development plan by using these methods. In an hasty action, specialists put usual methods away and started using complicated ones which needed a lot of information such as modeling. But the required data is not available most of the time, so the bases of their outcomes are probably unsatisfactory.

The concepts of philosophy which used for environmental impact assessment are being systematic, well-supported, clear, replicable and perceptible. To define these concepts and the assessment become more practical, a case study done in Golestan province. In this case study, two sites were suggested for sanitary landfill and developing compost plant in east and west of Golestan province. Assessment method that used in this case study is a combination of different methods which are spatial methods, Matrix, personal experiences, visiting the place and bringing expertise opinions. It'll be shown here that how researchers can simply improve the environmental impact assessment of landfill and compost plant in Golestan using philosophic concepts of ecology which are represented with help from Rapid Impact Assessment Matrix (RIAM) software.

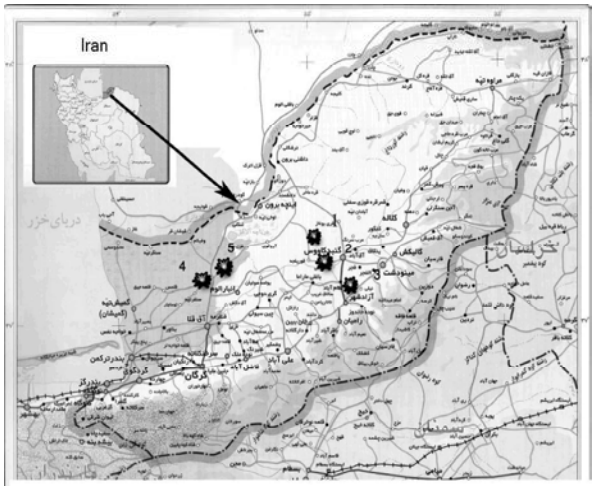

Fig. 1: Five studied locations in Golestan province for landfill and establish of compost plant

MATERIALS AND METHODS

The Golestan is a province which in this case study used for selecting suitable site for sanitary landfill, developing compost plant and environmental impact assessment of them. In this study this province is divided to two parts. One of them is the east part which Azad Shahr is center of it and the other one is the west part which Gorgan is center of it. Then, five sites are studied to find the best items for sanitary landfill and compost plant. The location of these sites is specified in figure 1.

Data collecting is the first,the most time-consuming and the most expensive step in environmental impact assessment. To assess the impacts of this project, we need environmental, economic and social information and data for these five sites. The researchers of this project used five methods which are providing general maps, tables, laboratory works, providing diagrams, field and general scientific observations to collect and organize information, in order to select the best site.

Using these information collecting methods, the most important problem is time limitation. So, the assessors gain general knowledge using general maps which are available. In some cases, some experiments are done for helping assessors to make decisions. For selecting a suitable sites, field observation plays an important role. Experts acquainted information about sites's features using direct observing. Besides, the features of sites are assessed in 13 subjects for increasing the rapidity of assessments [Table 1].

As it's seen from table 1, there are 13 social and environmental factors to environmental impact assessment. Each of these factors can be affected positively or negatively by the way that project is done.

The activities of traditional projects and their environmental and social impacts are indicated in table 2.

After analyzing the above data and using traditional methods, researchers have suggested the site 3 for the east part of Golestan and the site 4 for the west part of it as places for landfill and establishment of compost plant.

Table 1: Collected information and data by assessors of projects and methods

	Site 1	Site 2	Site 3	Site 4	Site 5
Climate and air quality	1&2&4	1&2&4	1&2&4	1&2&4	1&2&4
Water resources	1&2&3	1&2&3	1&2&3	1&2&3	1&2&3
Soil and Topography	2&3&5	2&3&5	2&3&5	2&3&5	2&3&5
noise	2&4	2&4	2&4	2&4	2&4
Land ecosystem	1&2&5	1&2&5	1&2&5	1&2&5	1&2&5
Aquatic ecosystem	1&5	1&5	1&5	1&5	1&5
Road traffic	5	5	5	5	5
Employment	2&6	2&6	2&6	2&6	2&6
Public health	6	6	6	6	6
Land use	5	5	5	5	5
landscape	1&5	1&5	1&5	1&5	1&5
Public participation	6	6	6	6	6
monuments	1&2	1&2	1&2	1&2	1&2

1-Maps 2-Tables 3-Laboratory 4-Diagram 5-field observation 6- General study

Table 2: Studying the impacts of the project activities on environment + = study is done - = study is not done closely

	Actions														
Factors	Setting up temporary factory	Excavation and Embank ment	Flatting and enclosure making	Trans ferring the soil and employees	Water consumption and transfer	Treating the sewage of employees	Treating the sewage of activities	Creating greenbelt	Trans ferring and gathering of wastes	providing the Fuel and Energy	Burying wastes and Producing compost process	Layering	Trans ferring the top soil	Extracting and Refining latexes	Gas Collecting
Climate and air quality	+	+	-	+	-	-	-	+	+	-	-	-	+	-	+
Water resources	-	-	-	-	-	-	-	-	+	-	-	-	-	+	+
Soil and topography	+	+	+	+	-	-	-	+	+	-	+	+	-	+	+
Noise	-	+	+	+	-	-	-	-	+	-	+	-	-	-	-
Land ecosystem	+	+	+	+	-	-	-	+	+	-	-	-	-	+	+
Aquatic ecosystem	-	-	-	+	-	-	-	-	+	-	+	-	-	-	-
Road traffic	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Employment	-	-	-	+	-	-	-	+	+	+	-	-	-	+	+
Public health	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Land use	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Landscapes	+	+	-	-	-	-	-	+	+	-	-	-	-	+	+
Public participation	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
monuments	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

Table 3: Categorized Impacts in RIAM software

Category in RIAM	Impacts in each category
PC	Climate and air quality - Water Resources- Soil and Topography- Noise
BE	Land ecosystem- Aquatic ecosystem- landscape
SC	Road traffic- Public health- Public participation- monuments
EO	Employment- landuse

Now, using the information of previous assessment, we are selecting the best site for establishment of compost plant and sanitary landfill using a systematic method (RIAM).

This method developed by Pastakia in 1998 and used as tools for analyzing and showing the result of comprehensive environmental assessments. This method was used at the first time to assess the impacts of tourism developement [13] .The advantages of using RIAM are being comprehensive, observing social and environmental factors together, being easy to use, simply and replicable and showing the impact of each factor separately. In the original RIAM, impacts are divided into four categories, 1) physical and chemical, 2) biological and ecological, 3) social and cultural and 4) economical and operational impact. This helps to identifying of impacts. As our aim was to categorize the cases according to their environmental and social impact,we classified the first two groups as environmental impact and the latter two groups as social impact. environmental and Social factors of this research are categorized in of table 3.

Main Criteria for Assessment in Riam Software Are Divided to Two Groups:

- Criteria which represent of importance
- Criteria which represent of value.

Then, the software analyses the criteria based on the scores of them and using special formulas [14].

The basic formula for the RIAM is [13]:
(A1)*(A2) =AT
(B1)+ (B2) + (B3) =BT
(AT)* (BT) =ES

In these formula (A1) and (A2) are different scores for the A group,and (B1), (B2) and (B3) are different scores for the B group. AT is the result of multiplying total scores of group A's scores, BT is the total sum of the B group's scores and ES is environmental scores [13]. scores and criteria of RIAM software are presented in table 4.

Table 4: The criteria of assessment [13]

Criteria	Grade	Description
	4	Important to national/international interests
	3	Important regionally
A1=the importance of impact	2	Important to areas immediately outside the local context
	1	Important only in the local context
	0	No geographical or other recognized importance
	+3	Major positive benefit
	+2	Significant improvement in status quo
	+1	Improvement in status quo
A2= the magnitude of change	0	No change in status quo
	-1	Negative change to status quo
	-2	Significant negative disadvantage or change
	-3	Major disadvantage or change
	1	No change/not applicable
B1= Permanence of the impact-causing activity	2	Temporary
	3	Permanent
	1	Not applicable
B2= Reversibility of impact	2	Reversible impact
	3	Irreversible impact
	1	No change/not applicable
B3= Accumulation of impact	2	Impact is non-cumulative
	3	Impact is cumulative or synergistic

Table 5: Achieved scores of sites 1 to 5

Criteria	A1					A2					B1					B2					B3				
Site	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Climate and air quality	3	3	3	3	3	-1	-3	-1	-1	-1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Water resources	3	3	3	3	3	-2	-3	0	-1	-3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2
Soil and Topography	2	3	2	2	2	-2	-3	-2	-1	-2	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2
Noise	2	2	2	2	2	-1	-3	-2	-1	-1	3	3	3	3	3	3	3	3	3	3	2	3	3	2	2
Land ecosystem	3	3	3	3	3	-1	-1	-3	-2	-1	3	3	3	3	3	3	3	3	3	3	2	2	3	2	2
Aquatic ecosystem	3	3	3	3	3	-1	-3	-1	-2	-3	3	3	3	3	3	3	3	3	3	3	2	3	2	2	3
Road traffic	2	2	2	2	2	-1	-1	-1	-1	-1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
employment	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	3	3	3	3	3
Public health	2	2	4	2	2	-1	-3	-1	-1	-1	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2
landuse	3	3	3	3	3	-2	-3	-1	-1	-1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
landscape	2	2	2	2	2	1	-3	1	1	-1	3	3	3	3	3	2	2	2	2	2	2	3	2	2	2
Public participation	3	3	2	3	3	1	1	1	1	1	3	2	2	2	2	2	2	2	2	2	3	3	3	3	3
monuments	4	4	3	4	4	0	0	-3	0	0	1	1	3	1	1	1	1	3	1	1	1	1	2	1	1

Table 6: The scores and description of given scores by the RIAM software. [13]

Range bands	Environmental score	Description of range bands
+E	(+72_+108)	Major positive change/impact
+D	(+36_+71)	Significant positive change/impact
+C	(+19_+35)	Moderately positive change/impact
+B	(+10_+18)	Positive change/impact
+A	(+1_+9)	Slightly positive change/impact
N	0	No change/status quo/not applicable
-A	(-1_-9)	Slightly negative change/impact
-B	(-10_-18)	Negative change/impact
-C	(-19_-35)	Moderately negative change/impact
-D	(-36_-71)	Significant negative change/impact
-E	(-72_-108)	Major negative change/impact

Using the information that are shown in table 4, A1, A2, B1, B2 and B3 will be scored in each of these 5 examined sites distinctly for all impacts which are affected by the project [Tables 1 and 2]. Generally, social impacts get positive but environmental factors get negative scores. There is no clear and significant relation between scores of environmental factors and score of social factors, because these criteria measure the impacts which are different [13].

Based on the information in the project, scoring the factors for each of these five sites is like the below table.The environmental scores (ES) were classified as follows [14,13]: this are from -E to +E. If the scores are close to -E, it means that the project has more negative impacts on the factor. On the other hand, if the scores are close to +E, it means that the project doesn't have

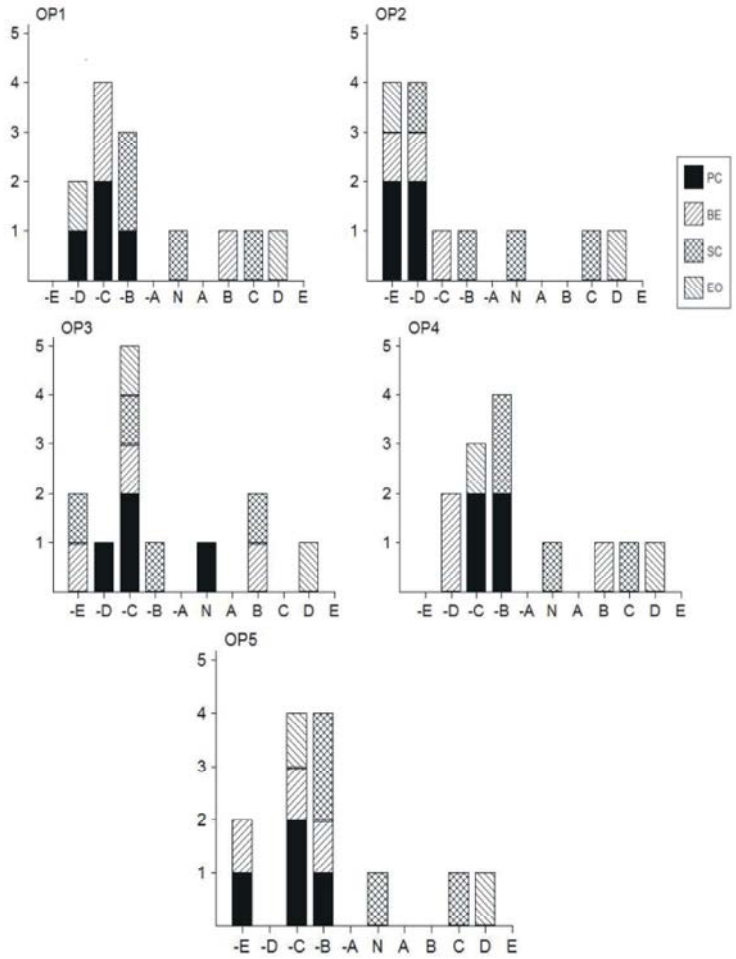

Fig. 2: Drawn diagrams by the RIAM software for each of five sites which are under study- sites are showed by numbers from 1 to 5.

negative effect on the factor, Furthermore, the project is also useful for it. It is worth saying that each of these given scores from -E to +E indicates the environmental scores which are shown in table 6.

The software gives some tables and diagrams as the results of analyzes. The assessors can select the best site easily by looking at diagrams. But for showing the result quantitatively, we need to use the tables. The software has drawn some diagrams of each five mentioned sites. These diagrams are shown in figure 2. Generally, the impacts of each project will be studied principally in terms of importance and measure within the framework of the RIAM. Then, the permanence, Reversibility and cumulativeness of impacts will also be studied in order to get more complete information of the environmental impact assessment.

Collecting previous researches of experts and providing simple and comprehensive methods of impacts is an important thing in this field. A simple and comprehensive method is more practical, attractive than the other methods and also it is more efficient to be used in different places. Even if we don't have enough information about the sites and environmental impacts in them, we can assess the impacts with help of this method to prevent use of personal opinions to some extent.

RESULT AND DESCUSION

From table 1 We can undrestand that there are 13 environmental factors for each of five sites. So, there will be 65 different situations for the sites and factors.

These 65 situations are combinations of using the map for 30 times (46%), the table for 35 times (53%), the laboratory test for 10 times (15%), the diagram for 10 times (15%), field observation for 5 times (7%) and the general study for 6 times (9%). It is obvious from table 1 that to

Table 7: The outline condition of mentioned five sites

	+E	+D	+C	+B	+A	N	-A	-B	-C	-D	-E
Site 1	0	1	1	1	0	1	0	3	4	2	0
Site 2	0	1	1	0	0	1	0	1	1	4	4
Site 3	0	1	0	2	0	1	0	1	5	1	2
Site 4	0	1	1	1	0	1	0	4	3	2	0
Site 5	0	1	1	0	0	1	0	4	4	0	2

Table 8: Calculated medians for each s

Grade	+E	+D	+C	+B	+A	N	-A	-B	-C	-D	-E
Median	90	53.5	27	14	5	0	-5	-14	-27	-53.5	-90

assess the results just one of those methods is used for 15 cases (23%). For 25 cases (38%), 2 methods and for 20 cases (30%), just 3 methods are used to make them more acceptable and consolidated. In addition, just the field observation is used to study the impact of the project on road traffic and landuse. General maps and field observations are used to study the impacts on the aquatic ecosystem and the landscape.For studying the impacts on employment, public health and public participation, only tables, general scientific studies or just general studies are used. We can understand from table 2 that project activities are outlined in 15 cases which have impact on 13 environmental factors. So, there will be 195 situations. Studying the factors which are analyzed directly and the factors which are considered indirectly, indicate that just 73 cases (37%) are studied directly. Then, experts made decisions based on the results to select suitable sites for landfill and establishment of compost plant.

Using the traditional method and amassing the above data, experts suggested the site 3 for the east part and the site 4 for the west part of Golestan as places for landfill establishment of compost plant.

On the other hand, from figure2 which is drawn by the RIAM software, we can understand, the site 4 has best scores than the others and it is effected negatively less than other sites. But for a full and more careful consideration, we use the table 7 which is drawn by the RIAM software.

The number of the scores which are gained by each site are written in this table. As it was said in table 4, each of these scores has a range of values. Just like table 8, We calculate the median of each range as it's range for making calculations.

Each score multiplied by the median of each range and their summation is a special number which is given to each site. The site which it's given number is higher and closer to positive numbers is less effected negatively by the project than the other sites, so it would be a more suitable site. The result of this simple mathematical operation is written below:

Site 1: (0*-90)+(2*-53.5)+(4*-27)+(3*-14)+(0*-5)+(1*0)+(0*5)+(1*14)+(1*27)+(1*53.5)+(0*90)= -162.5

Site 2: (4*-90)+(4*-53.5)+(1*-27)+(1*-14)+(0*-5)+(1*0)+(0*5)+(0*14)+(1*27)+(1*53.5)+(0*90)= -534.5

Site 3: (2*-90)+(1*-53.5)+(5*-27)+(1*-14)+(0*-5)+(1*0)+(0*5)+(2*14)+(0*27)+(1*53.5)+(0*90)= -301

Site 4: (0*-90)+(2*-53.5)+(3*-27)+(4*-14)+(0*-5)+(1*0)+(0*5)+(1*14)+(1*27)+(1*53.5)+(0*90)= -149.5

Site 5: (2*-90)+(0*-53.5)+(4*-27)+(4*-14)+(0*-5)+(1*0)+(0*5)+(0*14)+(1*27)+(1*53.5)+(0*90)= -263.5

We can understand from these numbers that sites 1 and 4 are the best cases for this special goals. Doing the project in these two sites will have the least negative impact on the environment but the most positive impact on the society.

The assessment result of researchers who haven't used the RIAM software was different (sites 3 and 4 as the best cases).

Summary: The five sites which are candidates for landfill and establishment of compost plant were studied using the traditional method which includes using the map, tables, diagram, limited laboratory tests, field observations, expertise viewpoints and newer method that is RIAM systematic method. Two methods were compared, In the first method, just 37% of possible impacts of these activities, have studied directly. Furthermore, laboratory tests are used just in 15% cases to indicate the impacts. Even though, the lack of using laboratory analysis in a method doesn't show that the method is good or bad, 65% of impacts are not examined directly in the traditional method. In addition, general maps, tables, diagram, field observations and expertise viewpoints are used in 85% of cases. All these items increase the measure of personal viewpoints and not calculated results about the project. Besides, they make the method less clarified, replicable, transferable and objective than the other methods. Using the RIAM, the divided impacts will be examined in two parts. The first part is importance, magnitude and permanence of impacts. The second part is Reversibility and cumulatively of impacts. Then, we make known a more progressive view of the environmental impact assessment with help from this method. Most of the experts are in agreement about these five mentioned bases which this method is based

on, so it is so successful. In addition, it is obvious that how each of these impacts are scored. It makes the method clearer and more replicable. Furthermore, the used concepts are useful for experts and other sites. Other experts can be asked easily to assess cases by the RIAM. The other advantage of using this method is drawing diagrams, tables and writing numbers which are in specified ranges. So, we can sum up rapidly that a part of the scientific philosophy, which is objectivity, being Reversible, transferable and clear, is included in the RIAM. The traditional method doesn't have such items. It is still possible to improve the RIAM and develop new scientific concepts in order to have better results. The results of the traditional method offer sites 3 and 4 but the RIAM offers sites 1 and 4 as the best choices. More developed methods for environmental impact assessment can not be improved, for the available needed information is not precise. Besides, most of the recent methods in Iran, which are used to environmental impact assessment, are affected by personal views of assessors. The RIAM is a good way to objectify the methods and assess environmental impacts more scientific than the others. This method can be used as a good method for having more developed and scientific methods in future.

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