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Full Length Research Paper

Modeling of future decades changes of Iran's precipitation as basic step in management for dry farming

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Human being has a very significant and pivotal role in forming the environment behavior. The growing human population, emissions of greenhouse gas, changing the earth's surface through building dams, etc cause great changes in the environmental system. The present research is an attempt to consider the changes in the rainfall and temperature in Iran in the coming decades influenced by the increase in the level of greenhouse gases. GFDL model was used for this purpose. For the simulation of changes in rainfall in Iran, 2025, 2050, 2075, and 2100 time scales were considered for the analysis. The results of the study showed that changes in the rainfall are incremental for cold seasons and decreasing in springs. Rainfall changes will also be incremental in summer. Furthermore, the simulated mean annual rainfall for 2025 in comparison with the long-term mean rainfall (1961 to 1990) shows a 30.09 mm increase in the level of rainfall in Iran. This increase is 52.83 mm in 2050, 43.75 mm in 2075, and finally 88 mm up to the year 2100. Areas like the North of Khorasan, North of Azarbayjan, North of Khorasan-e-Razavi and Golestan will experience the highest rate of decrease in the level of rainfall. On the other hand, areas such as the Eastern parts of the Persian Gulf and Bushehr, and north of Sistan-o-Baluchestan will have the highest rate of rainfall increase.

Key words: Modeling, management, agriculture, dry farming, Iran.

INTRODUCTION

Human being has a very significant and pivotal role in forming the behavioral patterns in the environment. The growing human population, emissions of greenhouse gas, changing the earth's surface through building dams, deforestation, etc cause evolutions in the environmental system (Asakereh, 2008; Roshan et al., 2010a). In 1816, John Tindle stated that changes in the amount of carbon dioxide in the atmosphere might lead to environmental changes. In 1896, Arhinus said that with the amount of carbon dioxide being doubled, the temperature of the atmosphere might increase about 5°C (Azizi, 2001).

Therefore, the changes in the environment are a phenomenon that is related to human beings and will lead to the destruction of the ecosystems in the planet earth (Pollyy, 2009).

Agriculture and natural resources are completely dependent on the weather conditions and the environment. Therefore, environmental variation and its changes have a determining role and effect, whether short-term (during the developing period) or long-term, on producing and preserving them. Numerous scientific resources and factual evidence related to the changing environment phenomenon indicate that despite the doubts and ambiguities (whether at the international or national level), this phenomenon is actually happening and soon all the activities and economic, social and cultural structures of the countries, especially, those located in the arid and semi-arid regions of the world, will be influenced by this phenomenon (Stafford, 2000; Darren et al., 2009). Environmental changes whether

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temporary as believed by some scientists or permanent according to some others, is an undeniable fact. Therefore, encountering this phenomenon requires awareness, readiness, programming, and enabling measures that help decrease the harmful effects caused by this process. This event the effect of which emerges in the form of global warming, change in the rainfall patterns and periods, an increase in the disasters such as flood, drought, extensive clouds of dust covering different areas, has had the most harmful effects on food-producing and agricultural activities, natural resources and the environment. At present, the change in the process of main environmental factors has been confirmed from different perspectives and is also observable as an objective reality. The harmful effects of lack of water and droughts, increase in the occurrence of floods, melting polar ice, and the seas overflowing, and finally gradual change of agricultural patterns in many parts of the world have been reported to be happening all over the world. In Iran also, despite the lack of scientific data and information in this regard, the harmful effects are clearly observable in the dry lakes and wetlands and limited water resources (You, 1996; Thomas, 2003; Lieshouta et al., 2004). Overall, change in the environment and global warming is a phenomenon that is happening right now and Iran has been and will be influenced by its harmful effects from different perspectives. These effects are obvious in economic, social and cultural aspects. Agriculture and natural resources will also be influenced by this phenomenon. For this reason, the changing environment is the most serious challenge facing them. The harmful effects of the changing environment might influence and endanger food security in the country in production, accessing, and consumption of food and also the sustenance of food providing and distributing systems. Lack of enough water will be one of the most important problems afflicting the country influencing all the structures, foundations and networks related to using and distributing water resources in agriculture (Jin et al., 2000; Mathews, 2008; Asakareh, 2008; jakob, 2009). Natural resources, especially jungles and pastures, which can be of great help in taking carbon dioxide in addition to their enormous benefits, will be negatively influenced from different perspectives by the environmental changes due to being overused. On the other hand, the harmful effects of the changing environment on the plants will lead to substantial changes in the traditional system especially; raising sheep and goats in the large scale will make providing grass and food supplies to the industrial animal husbandries and aviculture a serious problem. The negative effects of environmental changes will also influence strategic products such as wheat considering extensive stretches of farm land allocated to growing and harvesting it in the country. Generally, due to lack of enough water, increase in the temperature, and a decrease in the degrees of land suitability for farming some agricultural products, the production of these products will decrease to a large extent and in many cases the products that grow on less water and can adapt to the environmental changes will replace them. Moving to other lands for farming some products, for example moving the farming land from Saffron to the Northern parts of Khorasan-e-Razavi and Khorasan-e-Shomali provinces, is an example of this change (the analysis based on environmental models has confirmed such a process). It is expected that some fruit trees be cultivated in some more appropriate areas due to their need for a low temperature in a phase of their growth to provide the conditions for their blossoming and fruition. Therefore, the purpose of this study is to rebuild and remodel the changes in the rainfall in Iran in the future decades as a consequence of the environmental changes. Having a sound and thorough knowledge of the rainfall conditions in the future can help identify the potential for growing irrigated crops and dry farming in different areas of Iran in order to have the maximum output from agricultural products whether in irrigated lands or dry farming lands (Roshan et al., 2011).

MATERIALS AND METHODS

For the simulation of the effect of environmental changes on the changes in the rainfall in the future decades GFDL model was used. In this study, after collecting the weather forecast data and controlling the quality of the data, the obtained coefficients from the model were applied to the mean monthly rainfall. In this way, the rainfall data from different weather forecast agencies in Iran were simulated based on the model. GFDL is one of the most accurate models (with a high distinguishing power). It is a equilibrium model and the dimensions of any component of its network are at 7.8° altitude and at longitude 4.5° (4.5Lo°*7.8°La). For obtaining more specific information about the model, you can refer to www.GFDL.com. Simulation of the rainfall changes in Iran in the 4 periods of time, 2025, 2050, 2075, and 2100 was carried out and has been presented in the form of some maps (Roshan et al., 2010b). For developing the maps and analyzing them, GIS software was used. For this purpose, ArcGIS software was used. The main feature of geographical information system is in entering and analyzing the data and finally the output. Therefore, a complete database should be created. For developing the map, first its database was created. For this purpose, we needed to access Iran's numerical map, weather forecast stances and their information tables, and other related data. It should be noted that in developing the maps we used 2/5 by 2/5 zones and the center of every zone was selected as the gravity point of that zone.

Interpolation method was used to extend the data of the central point of these zones to other areas. There are different approaches to interpolation. The major approaches include:

1. Inverse Distance Weighted (IDW) that is used in regions with many slopes.
2. Spline used in level regions.
3. Kriging which is used in mountainous regions.

In this study, we used the second approach for interpolation. In this approach, the unknown values are estimated using a mathematical function. This function does this passing a curve through the specified points. The output from this approach should be a smooth

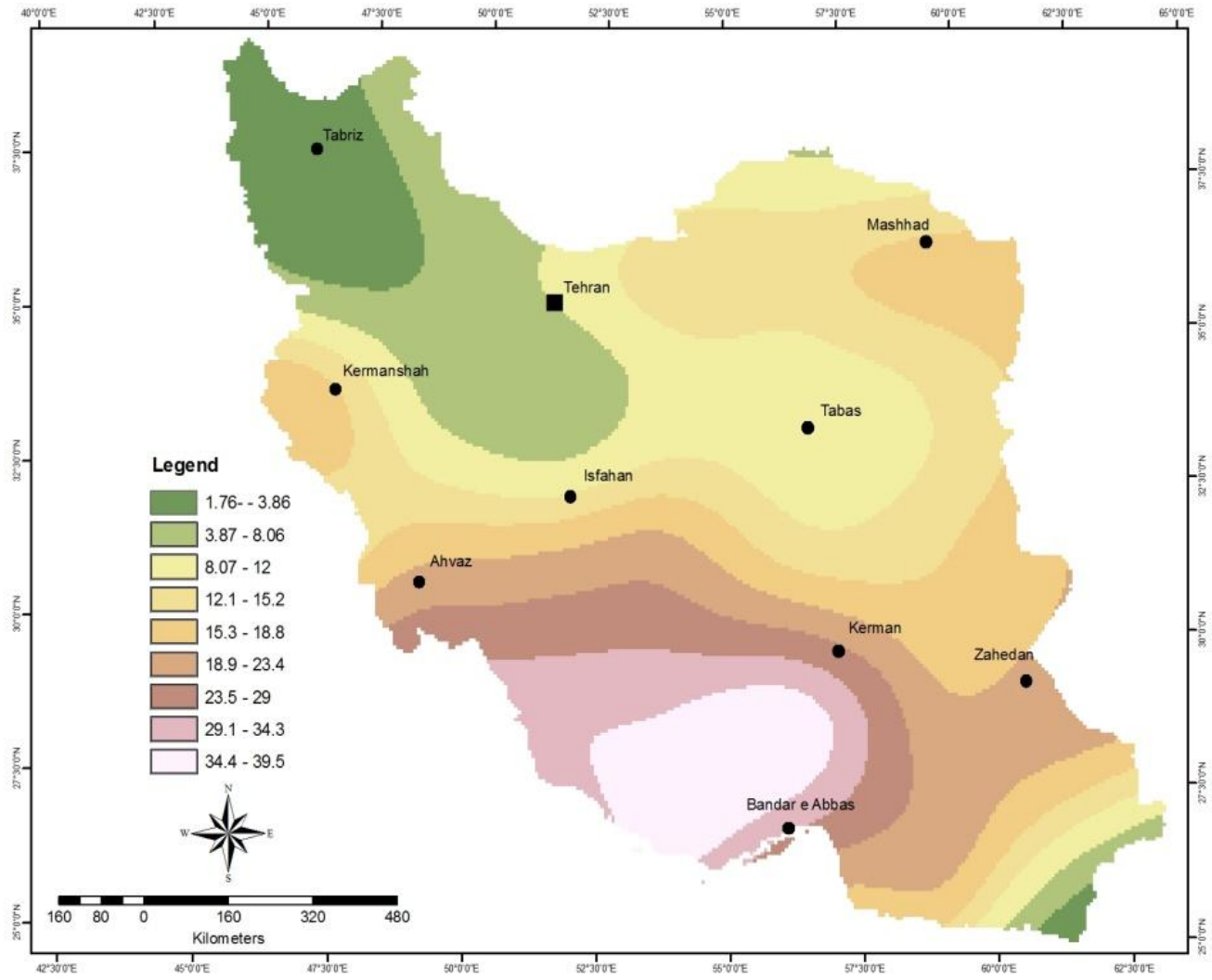

Figure 1. Simulation of the mean percentage of annual rainfall changes in 2025 using the results from the GFDL model.

surface. Finally, an output was produced from the developed maps.

Findings

We used the results from GFDL model for the simulation of the rainfall values in the 2025, 2050, 2075, and 2100 decades. Considering the annual and long-term mean rainfall (1961 to 1990) (282.66 mm) all the simulated periods will have an increase in the rainfall in comparison with the long-term mean rainfall (Table 1). The simulated values for 2025 based on the long-term mean rainfall (1961 to 1990) indicated an increase in the rainfall of up to 30.09 mm. The increase will be 52.83 in 2050, 43.75 in 2075 and 88 mm in 2100. The maximum increase in the rainfall is predicted to be 34 to 38% in 2025 in the regions such as east and south of Bushehr, and Eastern part of Fars and the Persian Gulf. On the other hand, the maximum decrease will be -1.65 and in the North of Azerbaijan (Figure 1). In the simulation carried out for the rainfall values for 2050, rainfall has been variable between -11.14 and 71.3%. Based on the analysis, the resulting values indicated that regions such as the North of Khorasan, North of Azerbaijan, North of Khoarasan-e-Razavi and Golestan will experience the highest decrease in the rainfall. On the other hand, east of the Persian Gulf and Bushehr, North of Sistan-o-Baluchestan will have the highest increase in the rainfall (Figure 2).

Simulation of the changes in the annual rainfall based on the long-term mean rainfall (1961 to 1990) indicates a 8 m decrease in rainfall in 2075 in comparison with the level of rainfall in 2050. During this period, variation in rainfall in different regions is calculated. Northwest of Golestan and the North of khorasan-e-Razavi will have a -19% decrease in rainfall which is really a large decrease in comparison with the long-term mean rainfall. But east of the Persian Gulf and Bushehr and also north of Sistan-o-Baluchestan will experience an increase of 71% in

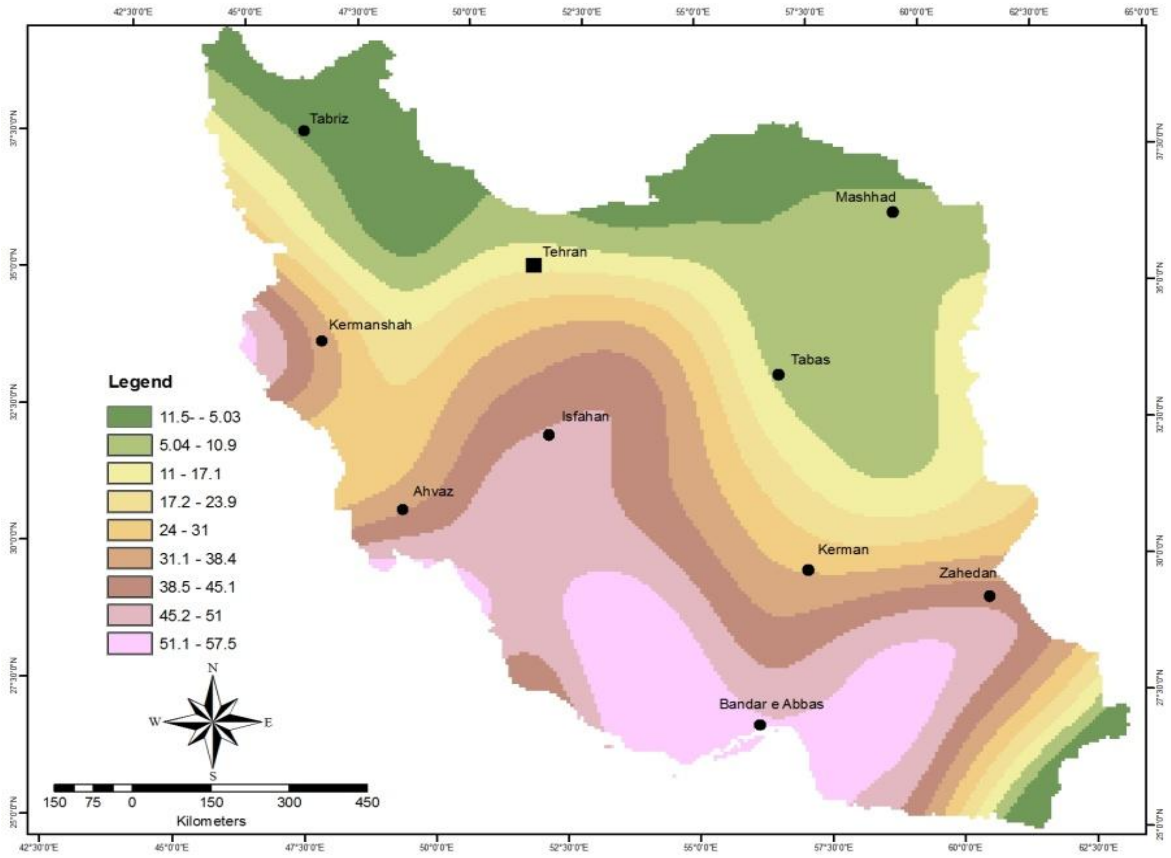

Figure 2. Simulation of the mean percentage of annual rainfall changes in 2050 using the results from the GFDL model.

comparison with the long-term mean rainfall and will have more favorable conditions in comparison with other regions (Figure 3).

In 2100, the percentage of mean rainfall changes has increased in comparison with the three previous periods. With an increase in the percentage of positive changes in the rainfall in Iran, the variation in rainfall has also increased. This variation ranges from 92 in 2075 to 140.5% in 2100. The highest decrease in rainfall of about -29% can be observed in 2100 in northeast of Iran in regions such as Chenaran, north of Khorasan-e-Razavi, Golestan, and Northwest of Golestan. Concerning the rate of increase in the rainfall, maximum positive increase was simulated in the east of Bushehr, Persian Gulf and south of Khuzestan which was calculated to be 110% (Figure 4).

Having analyzed the annual simulated data, there is also a need to go through findings related to monthly changes in the rainfall. In our comparison between different periods in January and the long-term mean rainfall (1961 to 1990), we found that the amount of rainfall has a decrease of -6.27% in 2025, -4.26% in 2050, -17.60% in 2075 and finally -21.96% in 2100. The mean amount of rainfall has been presented in Figure 4.

SUGGESTIONS

Solutions to decrease the harmful effects caused by environmental changes in Iran can be summarized as follows:

1. Developing a program for “action at the national level” for decreasing the harmful effects of environmental changes on agricultural products and the country’s natural resources and adaptation to the environmental change in the framework of preserving natural resources such as the jungles and pastures as the sources of absorbing carbon dioxide, encouraging economic activists and farmers to use appropriate and tested methods in agriculture being used in the world, (for example appropriate tillage systems) in order to prevent more emissions of carbon dioxide and absorbing it for producing agricultural products.
2. Making an attempt to develop a program for creating a balance between development and ecological ability in the country
3. Making and attempt to redirect researches in agriculture with a view to the environmental changes and the afflicting conditions (for example improving crop

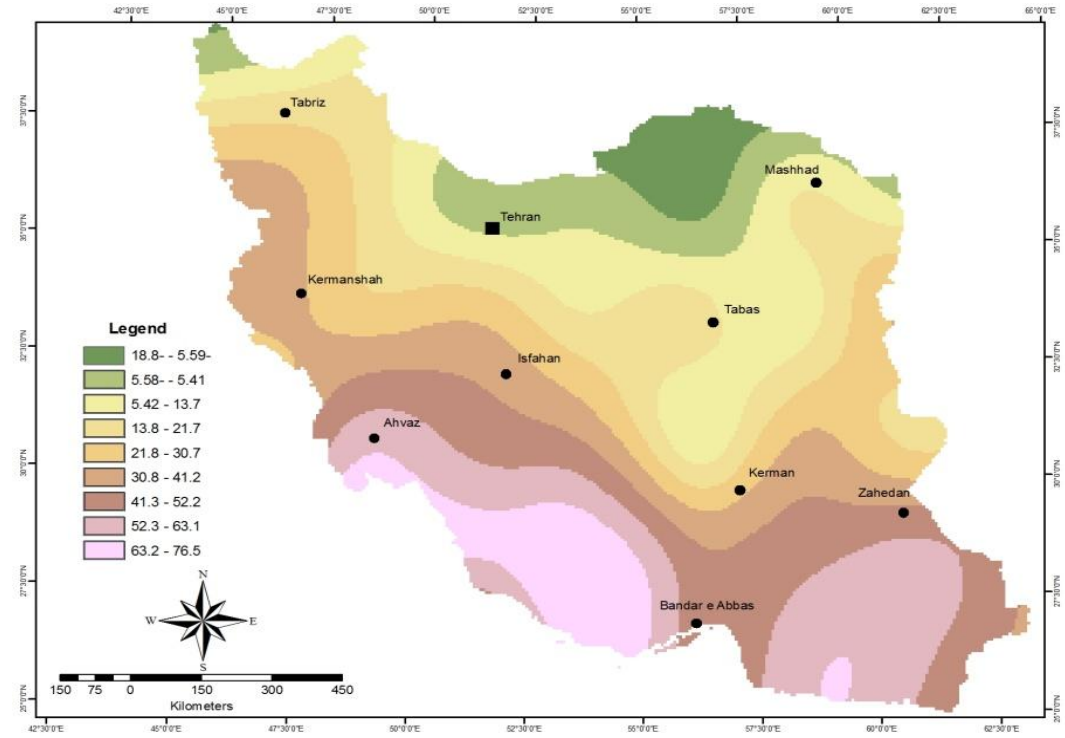

Figure 3. Simulation of the mean percentage of annual rainfall changes in 2075 using the results from the GFDL model.

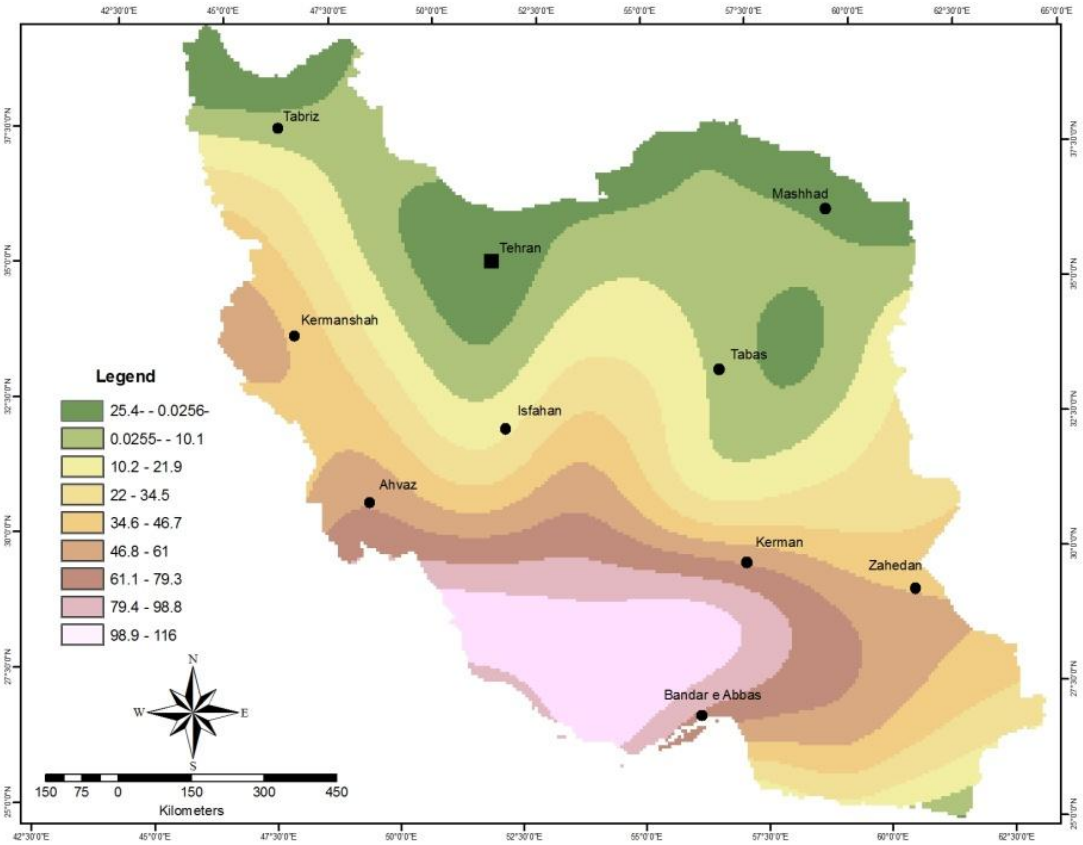

Figure 4. Simulation of mean annual changes in rainfall in 2100 using the results from GFDL model.

varieties resistant to heat and drought and adaptable to the spreading pests and new diseases and stimulating intensive competition in the weeds, exploiting plant life varieties for decreasing the tension resulting from environmental changes, an attempt to find replacement for the products, etc) and finally changing the current views on agriculture and move towards the kind of agriculture adaptable to the environment.

4. Paying attention to the peasant farmers can lead to a decrease in the harmful effects of environmental phenomena and also facilitate adaptation to these phenomena because it leads to variation in the production system.

5. Encouraging the society to change the pattern of food consumption based on the role these foods have in the emission of greenhouse gases (the best example of which is red meat).

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