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Iran's Water Crisis; Inducers, Challenges and Counter-Measures

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Abstract:

Similar to many countries in the world, experiencing extreme water shortages, the Islamic Republic of Iran is also in the midst of a serious water crisis. The looming crisis is being blamed on a number of factors including population growth and uneven distribution, natural phenomena such as droughts and changing climate patterns, and the mismanagement of existing water resources. The country's resources management is facing many subsequent challenges, including growing demand for water resources with proper quality, a considerable increase in the costs of supplying additional water, an urgent need to control water pollution, the uncontrolled exploitation of underground waters and the necessity to conserve these valuable resources. If immediate mitigation measures are not taken, the situation could become even more disastrous in the years to come. Being cognisant of the crisis' importance and its destructive influences, governmental authorities have begun evaluating their plans and programs and have devised long-term strategies to allay the water crisis.

This article describes the state of the country's threatening water crisis while also explaining in detail its main sources and the subsequent challenges it has caused the country to endure. Discussions on how governmental authorities are fighting the crisis and the state of the approaches, which they have pioneered, are also presented. Moreover, context of the Long-term Development Strategies for Iran's Water Resources is discussed from sustainable water management point of view with practical recommendations on the issue.

Key Words: *Iran, Water, Management, Sustainability, Crisis.*

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1. Introduction:

"More than 2.7 billion people will face severe water shortages by the year 2025 if the world continues consuming water at the same rate!" the United Nations has warned (BBC News, 22 March 2002). The world's supply of fresh water is running out. Already one person in five has no access to safe drinking water. Water is the most precious resource on the planet for human in the 21st century. Many areas of the world are already experiencing severe water shortages. In the next 2 decades it is estimated that freshwater use will increase by 40 percent worldwide. In addition, the water demands for industry, energy and agriculture will grow rapidly to keep up with growing population demand. In fact, today the world is facing a new problem called a "Water Crisis". This crisis is due to different issues in different countries. Regardless of its cause, the crisis has placed an extreme strain on water resources, livestock, and agriculture-ultimately, leading to greater hardship and human suffering.

In the 1950's only five countries faced a water shortage problem, in the beginning of the 21st century, however, there were 26 countries facing this serious problem having a population of over 300 million (Fig.1). Sixty-six countries with a population of approximately two third of the total earth population will confront serious problems of water shortage in 2050. Due to Hydrological Standards, countries, which have ARWA (Annual Renewable Water Availability) of less than 1,000 cubic meters per capita, suffer from water scarcity and if they have 1,000 to 1,700 cubic meters of ARWA per capita they face water stress (Panahi, 2000).

Covering an area of 1,648,195 square kilometres, Iran is a wide country (17th largest country of the world) located in southwest of Asia in Middle East neighbouring the Caspian Sea, Turkmenistan, Azerbaijan and Armenia in the north; Afghanistan and Pakistan in the east; Turkey and Iraq in the west and all southern borders of the country end to the coasts of the Persian Gulf and Sea of Oman. In total it has 15 neighbours including the Arab states in the Persian Gulf. Iran has a border of 8,731 kilometres of which 2,700 kilometres go for water borders and 6,031 kilometres for land borders (Iran Yellow Pages, 2004). With an estimated population of 71.4 million, Iran is the most populous country in the region, and the 16th most populous in the world (Unicef, 2004).

Series of massive, heavily eroded mountain ranges surround Iran's high interior basin. Most of the country is above 450 meters, one-sixth of it over 2,000 meters high. In sharp contrast are the coastal regions outside the mountain ring. In the north, the 650-kilometer strip along the Caspian Sea, never more than 110 kilometres wide and frequently narrowing to 16, falls sharply from the 3,000-meter summit to 27.5 meters below sea level. In the south, the land drops away from a 600 meters plateau, backed by a rugged escarpment three times as high, to meet the Persian Gulf and the Gulf of Oman. About 90 percent of Iran's land falls within the boundary of Iran's Plateau. More than half of the area is worn to mountains and highlands. One fourth of it comprises deserts, and arable lands only cover less than one fourth of the remaining area. The vast deserts of Iran stretch across the plateau from the northwest for a distance of about 650 kilometres to the southeast and beyond the frontier.

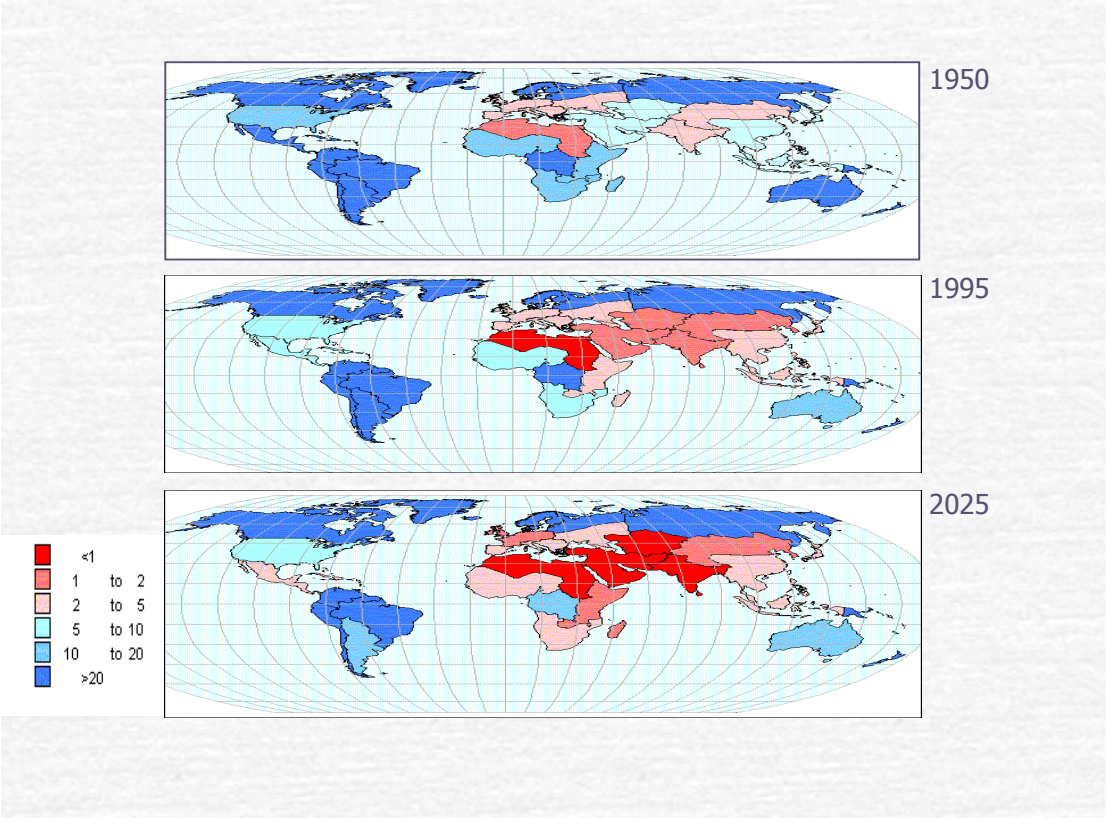

Fig.1 World's Annual Renewable Water Availability (1000 cubic meter/capita)
Source: (IWRMO, 2002)

Iran enjoys large climatic variability and has a complex climate, ranging from subtropical to sub-polar. In the summer, the temperature varies from 1° C in the northwest to 50° C at the head of the Persian Gulf. Precipitation also varies greatly, ranging from less than 100 mm/year in the central and southeast to about 1,000 mm/year in the Caspian region. The annual average is about 271 mm (Ardakanian, 2003). Table 1 presents a brief preview of the water cycle in Iran. Output of this cycle is the volume of 159 billion cubic meters as the Total Renewable Fresh Water Resources of which 130 billion is the Available Fresh Water Resources and the rest (29 billion) is the volume of Return Water from Consumption. Evidently, there are great differences in geographic and climatic conditions from north to south and east to west. Sixty-five percent of Iran is considered to be arid, 20 % is semi-arid, and only 15 % of the country has a humid and semi humid climate. Real fresh water lakes are exceedingly rare in Iran. There are probably no more than 10 considerable lakes in the whole country, most of them brackish and small in size. The few streams that empty into the desiccated central plateau dissipate themselves in saline marshes. There are several large rivers, but only one of them is navigable. Others are too steep and irregular. All streams are seasonal and variable; winter is normally the country's rainy season for the whole country; spring floods do enormous damage, and there is little water flow in summer when many streams disappear.

These great differences result in different distribution of water resources and consequently an uneven population distribution in the country. Typically, Iranians have preferred to live in regions, which have more water resources. About 50 % of the

country's population lives in the northern and western regions where over 70 percent of the country's water resources exist (Motiee, 2002).

Table 1 Brief Overview of Water Cycle in Iran *Source:* (Ardakanian, 2003)

	BCM (Billion Cubic Meters)
Internal Surface Water Resources	92
Transboundary Surface Water Resources	13
Total Surface Water Resources	105
Infiltration from Surface Water	13
Total Available Surface Water Resources	92
Direct Infiltration from Rainfall	25
Total Infiltration (Including Direct Infiltration from Rainfall)	38
Available Fresh Water Resources	130
Return Water from Consumption	29
Total Available Water Resources	***159***

Iran, with mostly arid and semi-arid climatic conditions, is facing an extreme water shortage. Presently, this problem has become more visible due to the recent droughts witnessed in specific parts of the country. The present lack of adequate water in the country is an especially serious situation considering Iran's population growth rate, which is estimated to be 1.08 % (CIA, 2003). Iran's ARWA is now less than 2,000 cubic meters per capita. This country is about to face Water stress and it is predicted that with the current population growth rate, Iran's ARWA will be reduced to 1300 in 2021 (Table 2) and less than 1000 cubic meters per capita in 2025 (Ardakanian, 2003) which means water scarcity. The crisis is being blamed on the mismanagement of existing water resources, population growth, and changing weather patterns. If immediate mitigation measures are not taken, the situation could become disastrous in the coming years.

Table 2 Iran's Renewable Fresh Water
Source: (Ardakanian, 2003)

Year	*Annual Renewable Water Availability* *(cubic meters per capita)*
1956	7,000
2001	2,000
2021	1,300

2. Crisis' Inducers:

Despite the fact that Iranians recognized the water crisis after observing the destructive impacts of the late droughts, it is obvious that the crisis is not merely the product of droughts. Interactions between several factors has induced this crisis:

2.1. Progressive Increase in Population: Since 1979 -the time of Islamic revolution in Iran- due to the cultural, social and economic change in Iran, there has been a progressive increase in population in such a way that during the last 25 years the population has increased from 30 to more than 70 million. This has increased the Water Demand dramatically. It is predicted that the population of Iran will pass 100 million in 2021(Fig. 2). Principally population growth is the main cause of global water crisis and it can be called as "The Mother of Water Crisis".

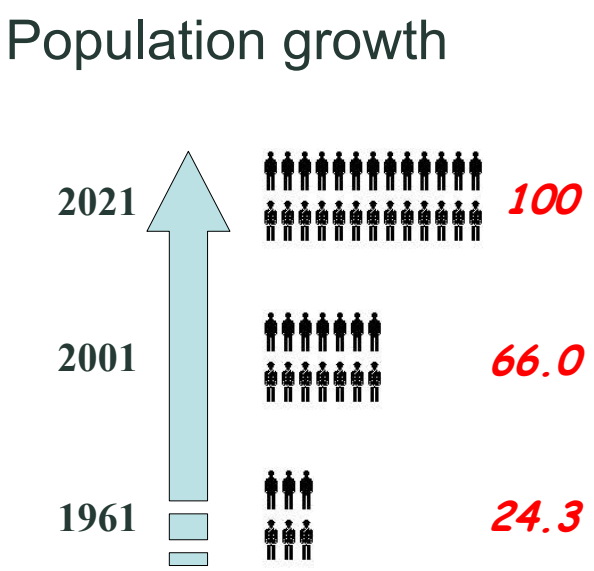

Fig. 2 Population Growth in Iran
Source: (Ardakanian, 2003)

2.2. Migration and Uneven Population Distribution: In search of better living conditions and job opportunities, a large amount of the rural population has migrated to urban areas, which has resulted in an increase in the urban population by 3.5 percent. This proposes many problems in providing water for the immigrants. The urban population has increased from 17 million in 1979 to 40 million in 2002 (Motiee, 2002). In 2000, Unicef reported that 95 percent of Iranians have access to improved drinking water sources of which 99 percent belong to urban areas and 89 percent to rural areas. Unicef also reported that only 81 percent of Iranians are supplied with improved sanitation facilities of which 86 percent live in urban areas while 74 percent in rural areas (Chech, 2003). These higher living standards in urban areas have created a great desire in the rural populations to leave their patrimonial cottages and migrate to the crowded and polluted cities.

Population distribution in Iran is very uneven because of the enormous variations in natural and climatic conditions, economic potentials, and concentration of industries and services across the country. For example, the eastern regions, the provinces of Kerman, Khorassan, and Sistan-and-Baluchestan, which cover about 42 percent of the country's surface area, house only 16.7 percent of the population. But the province of Tehran, which only covers 1.7 percent of the country's area, is inhabited by 20 percent of the country's population.

As seen in Figure 3 most Iranians have preferred to live in the north, north-west and south-west parts of the country while the vast lands of central, eastern, southern and south-eastern parts are vacant of habitants. According to Figures 3 and 4, the latter shows the GIS View of Water Networks in Country, it can be easily concluded that most Iranians live in regions with more natural water supplies. Although this seems acceptable to a certain extent, many cities in Iran are now over-populated and therefore under critical water conditions. For instance, more than 14 million people live in Tehran – the capital – and its suburbs. Therefore, this city is facing a serious water shortage. Foltz 2002 states that: "The average water consumption in Tehran is nearly double that of Western European nations."

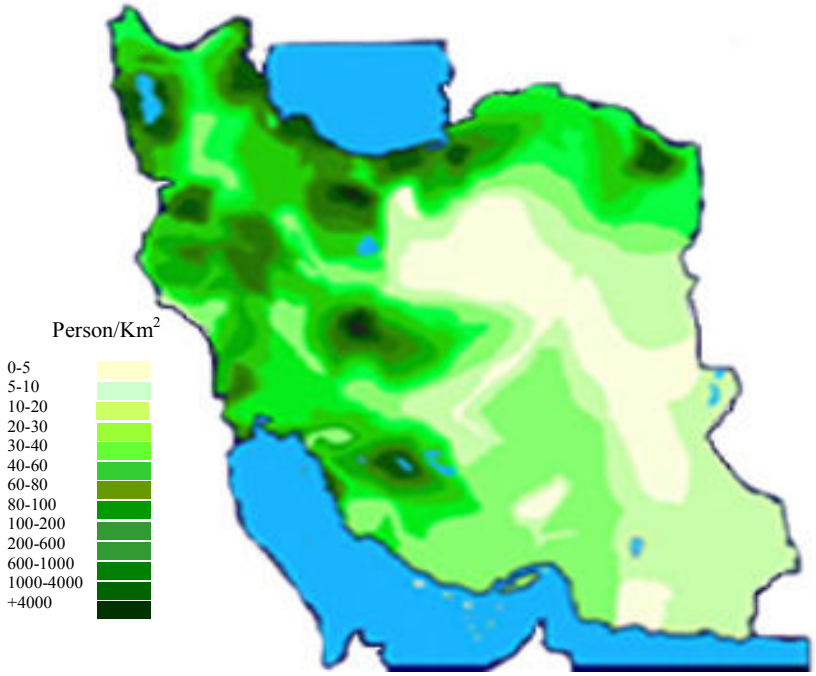

Fig. 3 Distribution Map of population in Iran (1996)
Source: (http://www.eri.u-tokyo.ac.jp/KABE-LAB/Bam-Hossein/SeisVul.htm)

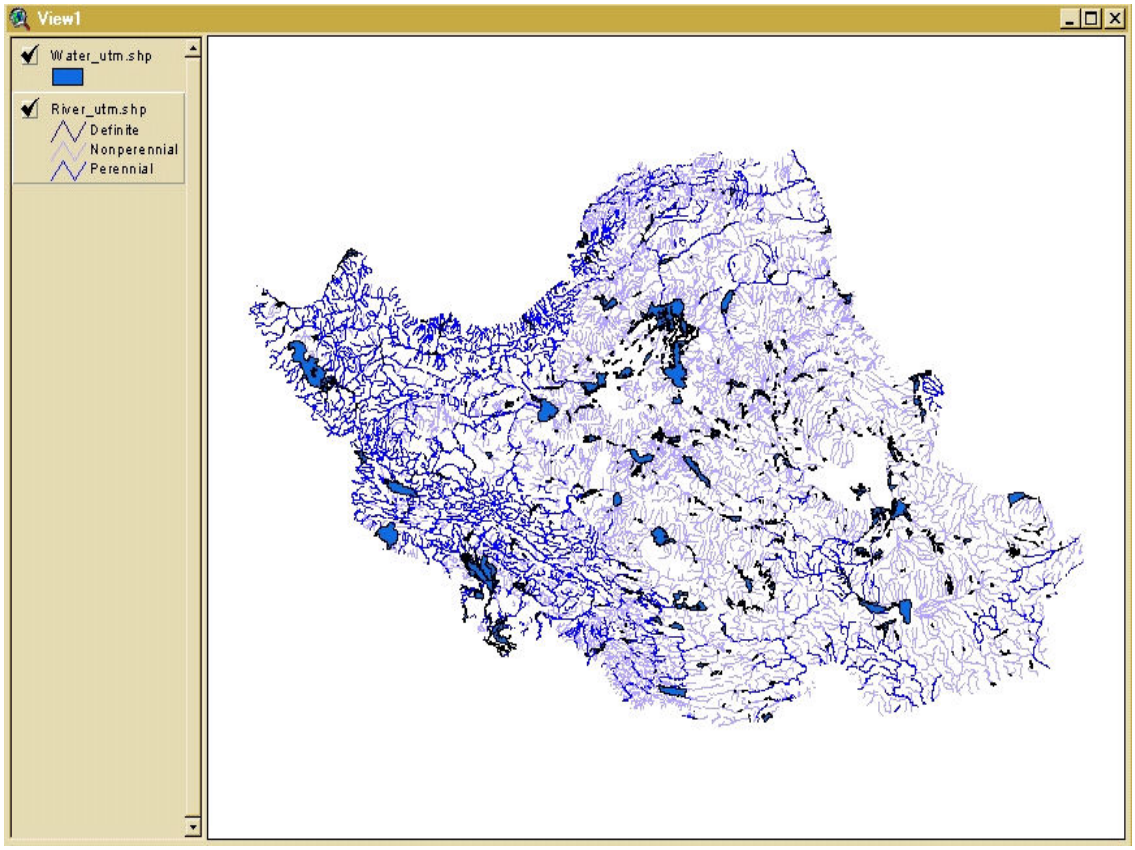

Fig. 4 GIS View of Water Networks of the Country
Source: (Motiee, 2003)

2.3. Appearance of Droughts in the World as well as Iran: Droughts have placed an extreme strain on water resources, drinking water supply systems, livestock, and agriculture. They are the cause of great hardship and human suffering, impacting vulnerable population groups, particularly in rural areas who have no alternative source of income. The recent droughts have adversely affected nearly all drinking water supply systems in both rural and urban areas. In over 70 percent of rural areas, the flow of water has been disrupted to varying degrees – from moderate to severe. Some 37 million people (about 50 per cent of Iran's total population) were affected. Almost 80 percent of drinking-water wells suffered from low water yield, a drop in the water table, intrusion of salt water, or complete dryness (UN, 2000). The magnitude of the droughts was overwhelming and in spite of the government's efforts, the available resources already overwhelmed and therefore unable to adequately deal the situation.

2.4. Excessive Economical Reliance on Agriculture: One third of Iran's economy relies on agriculture. Since 1979 Iran's economic policy has been heavily focused on agriculture (non-oil production policy). Because of international conditions and issues arising from the country's revolution, production and exports have consistently been in a state of oscillation in the decades following the revolution. In fact while there is abundant access to land and labour, water has been the major limiting factor for Iranian agriculture (Babakani, 2000). About 92.8 percent of Iran's water consumption in 2001 was due to

agriculture while only 1.2 and 6 percent was consumed by the industry and domestic sectors, respectively (Ardakanian, 2003). The UN University states that as urban populations grow, water use will need to shift from agricultural to municipal and industrial uses. This will make allocation decisions between different sectors difficult (UN, 1999). As displayed in Figure 5, Iranian governors have planned to change the water allocation between the sectors.

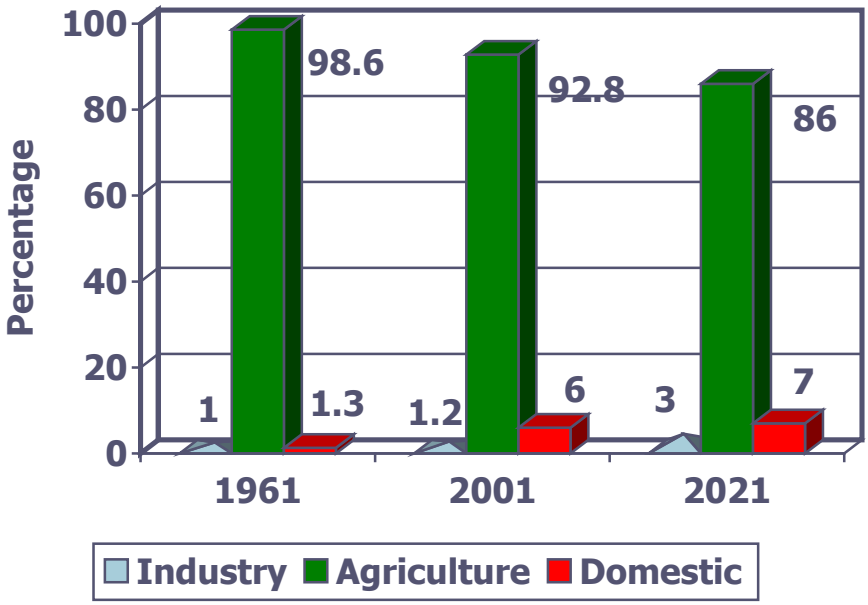

Fig. 5 Iran's Water Consumption at a glance
Source: (Ardakanian, 2003

2.5. Mismanagement: In years when rainfall is normal or above normal, the country generally does not face any water shortage; however, in below average rainfall periods, it does. The planners, it is assumed, are responsible to foresee and carry out effective water resources development and management planning to meet these future challenges. Sadly, however, this has not occurred. Since 1999 Iran has faced a water crisis so severe that in response, the Iranian government began accepting foreign aid for only the second time since the Islamic revolution in 1979 (the first was on the occasion of a massive earthquake in 1990). Yet many academics and other experts inside Iran insist that the water crisis is only partly drought-related; they claim that the mismanagement of water resources is the more significant cause of the current crisis (Foltz, 2002). Unfortunately news reports and governments press releases in Iran have consistently blamed the crisis on the droughts, treating it as an uncontrollable natural disaster. Many still imagine that what they are seeing is a passing crisis and not a permanent trend. The outcomes of this mismanagement can be observed in any water issue in Iran. Foltz (2002) -in his paper about Iran's water crisis- contended that some Iranian water experts suppose that present water crisis in the country is fifty percent due to a bad water management.

3. Long-Term Challenges:

The water crisis has confronted the Iranian government with many challenges. The main long-term challenges are as follows:

3.1. Consumed Portion of the Total Renewable Fresh Water Resources: Currently, Iran consumes 73.8% of its Total Renewable Fresh Water Resources annually (Fig.7). Based on international standards, each country that consumes more than 40% of its Total Renewable Fresh Water Resources is considered to suffer from Water Stress. According to this criterion, Iran is presently experiencing Water Stress (IMPO, 2002).

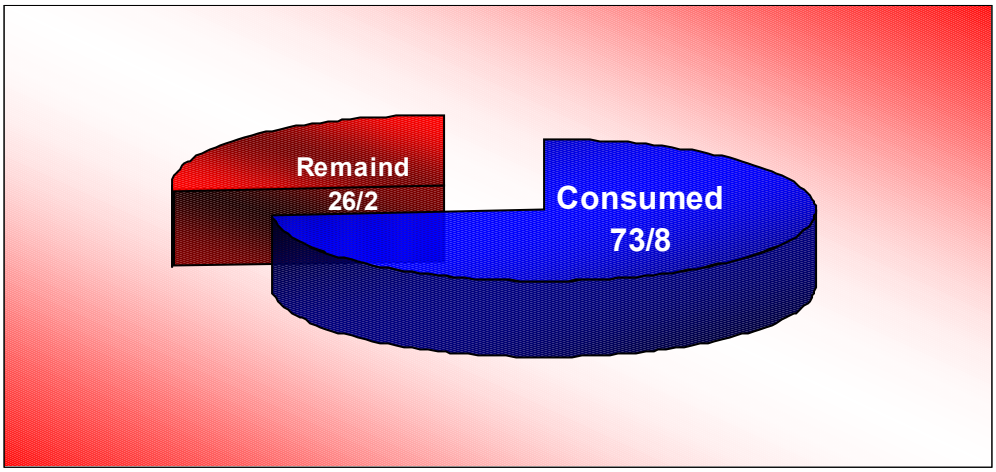

Fig.7 Consumed Portion of Total Renewable Fresh Water Resources in Iran
Source: (Madani, 2003)

3.2. Diminishment of the Annual Renewable Water Availability (ARWA): Water consumption increases with population growth and lack of proper consumption culture. Iranians have not become accustomed to an arid and semiarid life although they are living in such conditions. They consume too much water in a manner that only people with abundant water resources can do. The country's population is growing continuously. People are increasingly in need of more water whether for drinking purposes, farming, industry or other means of their food security, or social welfare and health matters. Therefore, while the amount of water produced is approximately the same, its consumption has gradually increased. According to present Iranian standards, each citizen may consume an average maximum of 150 to 175 liters of water in per day, for drinking, washing, and bathing purposes. The Iranian water planners have reflected this precisely calculated standard in their budget. However, in practice, the inhabitants of most cities, consume 1.5 to 2 times that amount (Panahi, 2000). The current ARWA of Iran is about 1800 cubic meters per capita and this will decrease dramatically in the near future. According to the International Hydrological Standards, Iran will soon be added to the group of countries which have Water Stress—defined as an ARWA between 1000 and 1300 cubic meters per capita—and between the years 2025 and 2050 will have Water Scarcity—defined as an ARWA less than 1000 cubic meters per capita.

3.3. Water Quality: Dissemination of water resources contamination is one symptom of current water crisis in Iran and is one of the main challenges facing Iranian planners. Serious sanitation problems such as the present unreliable water supply systems, the inconsistent quality of drinking water, the poor performance of water distribution networks, the lack of adequate wastewater collection and treatment systems coupled with rapid population growth and expansion of urban centres has prompted the government to consider water supply and sanitation projects as high priority. Areas without wastewater either use seepage pits or discharge their wastewater in open channels, rivers or in open grounds creating wastewater pools, polluting the soil and water resources, and creating health hazards. The discharge of untreated municipal and industrial effluents, the drainage from agricultural lands, and the uncontrolled discharge of solid wastes directly into the rivers and their tributaries have considerably degraded the water quality of some rivers. Available treatment facilities have proved to be insufficient in producing drinking water with adequate quality. Excessive extraction of ground water in certain regions has become alarming. People who extract beyond permissible levels in those areas cause the salty or polluted water flows in the reservoirs as a substitute to the used water so the remaining good quality waters will become unusable as well. The water quality in the Persian Gulf coastline, the desert areas, and some other places is very poor as they mostly have salty water.

3.4. Water Decline in Aquifers: Over the past four decades, Iranian farmers and others close to the land have observed water tables drop as one well after another dries up and formerly fertile lands are forcibly taken out of production. In any country, the underground water resources are considered to be a temporary reserve for the draught years. In other words, these resources are reserved for use for one or two years in draught periods, with the provision that they would be replenished later. Using underground water resources is a temporary and short-term solution to the water shortage problem. If such waters are continually extracted, the reservoirs will be destroyed. Presently, 55% of Iran's needs are met through underground water consumption. Of the country's 612 plains about 150 are classified as restricted areas with critical conditions. The amount of extracted water is more than what is replenished (Panahi, 2000). While the Annual Extractable Ground Water Volume for the entire country is 56.5 billion cubic meters, the withdrawal is 61.3 billion cubic meters. This means that an extra 4.8 billion cubic meters is being extracted (IMPO, 2003). When the wells dry up, the preferred solution has been to simply to dig a deeper well and get a larger pump (Foltz, 2002). Such further extraction, whether illegal or by old permits, occurs in restricted areas and causing the water level in these plains to decline considerably, falling by as much as 1.5 meters a year in some places (Panahi, 2000).

3.5. Natural Hazards: Many of the Asian and Pacific developing countries are situated in the world's hazard belts and are subject to floods, droughts, earthquakes, windstorms, and other natural phenomenon. Of the 40 types of unexpected disasters that have occurred in the world, Iran has experienced 31 of them. In other words Iran is one of the 10 disaster prone countries in the world. Statistics published by the Unexpected Events Headquarters indicates that each year in the last decade of twentieth century Iran has suffered

approximately 1 trillion Rials worth of damages, which is equivalent to about 1.2 billion US Dollars. Nearly 70% of this amount has been related to drought and flooding, which are the most important disasters related to water issues in Iran (Panahi, 2000). From Tables 3 and 4, which the former shows the country's most strenuous droughts and floods and the number of people affected and the latter is the country's profile for the two disasters, it is evident that these two natural disasters are major considerations for the Iranian government. Although the impact of droughts and floods are more or less the same for the country's inhabitants, Iranian planners have not paid attention to them simultaneously and their priority over the subject seems completely periodic. During drought periods there are various workshops and seminars on the topics related to droughts while there is little mention of floods. However, as soon as the first flood takes place they will neglect droughts and redirect their focus entirely to floods.

Table 3 Iran's Severest Floods and Droughts and the number of people affected (1964- 2002)
Source: (EM-DAT Emergency Disasters Data Base, 2005)
(http://www.em-dat.net)

Disaster	Date	No. of Affected People
Drought	2000	37,000,000
Drought	July 2001	25,000,000
Flood	August 2001	1,200,000
Flood	July 1980	950,000
Drought	1964	625,000
Flood	February 1993	484,728
Flood	August 2002	200,000

Table 4 Iran Droughts and Flood Profile (1909-2005)
Source: (EM-DAT Emergency Disasters Data Base**,** 2005)
(http://www.em-dat.net)

	Number of Events	Number of Killed	Number of Injured	Number of Homeless	Number of Affected	Number of Total Affected	Estimated Damage in ('000 US$)
Drought	4	0	0	0	62,625,000	62,625,000	9,500,000
Average per event		0	0	0	15,656,250	15,656,250	2,375,000
Flood	61	7,576	582	194,620	3,362,901	3,558,103	3,733,220
Average per event		124	10	3,191	55,130	58,330	61,200

3.6. Supply and Demand Gap: As the population increases, the Water Demand will rise dramatically. If the government does not take the necessary steps in order to supply its citizens with new water sources, the current supply will not be sufficient to meet the needs of the people. In fact the country's present water supply capacity is inadequate for the demands of the population even right now. There is a considerable gap between supply and demand and as the years pass, this gap will continue to magnify. The Water Demand is increasing daily due to the positive population growth rate in Iran. The ratio of the Water Demand in 2021 -when the population will be over 100 million- to the Water Demand in 2000 is between 1.3 and 1.5 in Iran. Figure 7 is a schematic diagram of the water supply and demand in Iran over time. The population growth resulting in more demand is progressive while the supply only grows step by step by providing new sources of water and adding them to the supply network.

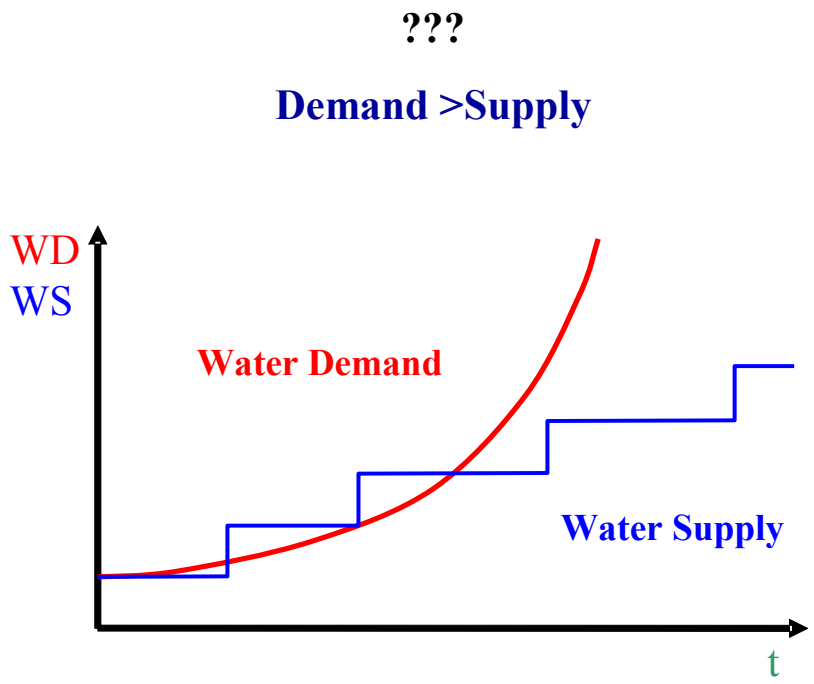

Fig. 7 Schematic diagram of supply and demand in Iran considering the time factor
source: (Madani, 2003)

3.7. Congestion of Ongoing Projects: Implementation of new water projects, in order to supply the inhabitants with water, is inevitable. It should not be neglected, however, that the number of the ongoing projects should be proportionate to the government's support capacity. Regretfully it should be noted that probably the Iranian planners have not taken this fact into consideration. This lack of careful consideration has resulted in prolonged implementation of different projects, which has consequently resulted in great financial harm to the country's economy due to changing of inflation and interest rates; ultimately leading to rising costs. Moreover they have not been able to fulfil their goal of completing projects in the appropriate timeframe. In fact, the government now lacks the budget necessary for financing the willing projects. Before the victory of Islamic

Revolution, about 4% of Iran's budget for construction purposes was allocated to the country's water preservation and maintenance. Since the revolution this amount has increased to 10 or 11%. Nevertheless, despite the tripling of Water Department's budget, it is not enough and this budget still cannot fill the void (Panahi, 2000).

3.8. Water Waste and Irrigation Efficiency: According to statistics published by Iran's Water and Sewage Department, there is almost an amount of 32 % unaccounted water which includes the water wasted due to leaking in decayed city networks, the water illegally used by some consumers and unaccounted water due to the absence of proper water supply systems and water meters. With more control and improvement of the network systems, this amount can be reduced from the current 32 to 8 or 9 percent. This amount of water loss in the drinking water section is a very precious amount due to the very high cost of the potable water's production and treatment. Along with this loss, Iranians are also faced with the irrational use of drinking water (Panahi, 2000). Moreover, there is also the issue of low irrigation efficiency, which is between 20 to 27 % (Madani, 2003). Considering the current portion of consumed water allocated to the agricultural sector, which is more than 90%, more than 63 % of the water resources of the country are wasted during irrigation; this is comparable to the magnitude of the impacts of natural hazards.

3.9. Users Competition and Water War: Water is likely to become a growing source of tension and fierce competition between parties in the country if present trends continue; the consequences will be most devastating for the poor. Not only is the toll a human tragedy, it also means these that people will be less able to carry on productive lives, which will lead to the undermining of social and economic development. As the vast majority of water is used in agricultural production, there are conflicting objectives between the desire to conserve and enhance diminishing water resources and the need to increase water availability and food production for a growing population. Specialists state that in the near future there will be an ideological controversy for water, which will not be local but rather international, and that it will be related to its suitability and usage. In many places of the world and mainly in areas where there is a water shortage, like the Middle East, there is danger of a possible war outbreak. The crisis over water in the Middle East is escalating. Despite existing agreements, dwindling resources – increasingly affected by pollution, agricultural and industrial initiatives, and population growth – have elevated the strategic importance of water in the region. For Middle Eastern nations, many already treading the razor's edge of conflict, water is becoming a catalyst for confrontation – an issue of national security and foreign policy as well as domestic stability. Water is now redrawing the geopolitical landscape of the Middle East. Facing historical, psychological, and political barriers that have impeded cooperation and deadlocked diplomacy, nations in the region are sliding toward conflict over water. Water's growing role in the emerging hydropolitics of the region has stressed the need for a new approach to safeguard this diminishing resource (Berman et al., 1999). It is exceedingly vital for the Iranian governors to withhold these conflicts.

3.10. Environmental Degradation: Iran is faced with many environmental problems. Iran's failure to move beyond conservation policies towards a sustainable development

has manifested itself into a range of problems today. In addition to deforestation and desertification issues across much of Iran's arid territory, industrial and urban waste water runoff has contaminated a number of rivers and coastal waters and threatened drinking water supplies; wetlands and reservoirs are increasingly being destroyed under the pretext of creating industrial and agricultural lands while oil and chemical spills in the Persian Gulf and Caspian Sea continue to pollute the seas and harm aquatic life. The Caspian Sea region is facing a number of environmental problems due to the international rush to develop the Caspian's oil and gas (EIA, 2003). Far more serious, however, are the agricultural, industrial, and municipal wastes – mostly untreated – that pour into the rivers, lakes, and seas. The agricultural pesticides and chemicals run-off into the country's water resources and are threats to the flora and fauna. Environmental changes brought about as a result of unsustainable exploitation of Iran's water resources now threaten entire communities with extinction. On the Iranian plateau the change in water technology is draining aquifers, altering the distribution of towns and villages, and transforming the lives of Iranian villagers. Evidence suggests that deep wells have made many small farmers dependent on well owners, failed to increase agricultural production significantly, and bode poorly for the long-term survival of many long-established settlements. The desire for short-term benefits has prevailed; the long- term costs remain to be seen. It is somewhat discouraging to see that, despite continuous protests from within the academia, the vast majority of Iran's government officials continue to believe that the best solution to the water crisis is simply to build more dams – as many as possible, in fact. This is in spite of the many recent scientific studies conducted by Iranian scholars, which, like similar studies elsewhere, have shown that such policies lead to the net loss of available water resources (Foltz, 2002) and have had dramatic effects on the flora and fauna.

4. Counter-Measures:

The water crisis is a cause of concern for the Iranian governors and planners. The search for solutions continues to be a great source of frustration and anxiety. Different governmental authorities have pioneered various approaches to find appropriate strategies to overcome the crisis and counteract the related challenges. The outcomes of two main approaches, which have been fulfiled in recent years, are "The Integrated Climatic Compatibility Program" and "The Integrated Water Scheme". It is not void of value to briefly mention the goals and outcomes of such studies:

4.1. The Integrated Climatic Compatibility Program: This approach was pioneered by a cooperative team consisting of representatives of the Iranian Ministry of Energy, Ministry of Agriculture-Jihad, Management and Planning Organization (IMPO), and Meteorological Organization of Iran and was finalized in 2002. The main objective of this program was to make the country's water resources management, exploitation and development plans compatible to the arid and semi-arid climatic conditions of the different regions (30 hydrological basins) of the country. The purpose of establishing such compatibility is to install a balance between supply and demand for each basin in long run (IMPO, 2002). The survey attempts to overcome the crisis by arrangement of

the different water related issues, capacity building, and supply and demand management.

In order to organize such an arrangement, it suggests the following different methods:

- Compilation of national water resources strategy, considering all the socio-economical and environmental dimensions. This strategy must conform to long-term watershed management programs. It is also recommended that the water resources management should be a priority for the Iranian government since Iran is currently facing a severe water shortage.
- Structural alterations to the present rules and regulations.
- Creation of water management organizations in each basin.
- Increasing the participation of water consumers and operators in management procedures.
- Determination of the limits of water privatisation.
- Monitoring and creating water databases for planners and consumers.
- Capacity building.

The program has made the following recommendations for demand control and management:

- Preparing a regional consumption pattern for each basin, which is appropriate for its hydrological conditions.
- Promotion of appropriate consumption culture.
- Pricing of water considering the economic value of water in the corresponding basin, as well as the climatic conditions and water accessibility in that region.
- Providing services to irrigators and rectification of the cultivation pattern.

For the supply management, the program insists on the followings:

- Water quality supervision and prevention of water resources contamination and environmental pollution.
- Reformation and improvement of water distribution methods.
- Compilation of water operation order and improvement of the water resources maintenance and exploitation system.

4.2. The Integrated Water Scheme: This study was performed by the IWRMO (Iran Water Resources Management Organization) and was finalized in 2002. The main goal of this study was to find a strategy to obtain, maintain, and operate the national water resources in a manner, which complies with government's sustainable development programs. This strategy should also support the survival of Iran’s water resources in order to establish regional balances, secure the environmental needs, and safeguard future generations' rights. The approach assumes three scenarios for next two decades:

I. Consumption of the national water resources up to the maximum level.

II. Minimum water consumption and maximum effort in order to preserve resources, reduce the waste, and increase efficiency.

III. Considerate consumption of water resources and coincident efforts to manage the water consumption (simultaneous management of water supply and demand) (IWRMO, 2002).

The occurrence of the first scenario is only possible when there is no concern regarding water resources and would have dramatic effects on the resources of the country. This pessimistic view is not reasonable for Iran's future, considering the country's present water resources management state. Performing the second scenario (optimistic view) is not realistic either. This scenario is not practical in short-run and near future. Apparently, the third scenario seems more reliable to take place in next two decades, considering the current situation. Consequently, this study approves the third scenario for the next two decades of water resources management in Iran and makes the following recommendations based on the simultaneous supply and demand management to overcome the crisis:

1) Reformation of water supplying structure and consumption pattern. This can be fulfilled by reduction of the ground water consumption rate, artificial aquifer recharge, increasing the consuming portion of surface waters (internal and frontier rivers, etc.), and utilizing new resources such as wastewaters, saline and semi-saline waters.
2) Conservation of water quality and the environment.
3) Consideration of irrigation and network supply efficiency and different economical factors in water harvesting and consumption. This will be implemented by efficient use of industrial and agricultural water while considering land use planning, water market economy, and pricing the water appropriate for the low-income level of the society.
4) Harness of new surface water resources and sustainable distribution of water.
5) Special attention to coordination among various sectors, management methods and public participation.
6) Harness and consumption of frontier waters, which flow out of the country, considering political priorities and national benefits.
7) Noticing the regional water market and water exchange (beyond the national borders).

4.3. Long-Term Development Strategies for Iran's Water Resources: In order to overcome the current water crisis, the Iranian government has tried to take the necessary steps in preparing long-term development strategies for their water resources (in 2003). The prepared document is based mostly on two proposed approaches, which are entitled "The Integrated Climatic Compatibility Program", and "The Integrated Water Scheme", Both strategies were finalized in 2002. Ardakanian (2004), the deputy minister for Iranian

water affairs, states that “The valuable document of Long-Term Development Strategies for Iran's Water Resources will be a suitable guide to compile the medium and short term plans of national water management resulting in the optimized exploitation of national water resources by uniting all the arenas of water management. This considerable measure fulfilled by the Office of the Deputy Minister for Water Affairs, realizing the global slogan of "Water is Everybody's Business" in 2003 the International Year of Freshwater.” This document has been regarded as a pioneering measure for international policies. In accordance with the decision made by the world leaders at the Summit on Sustainable Development (Johannesburg September 2002), all countries are obliged to compile their integrated water management plan by 2005. Iran was the only country in the region to have compiled and approved its plan by 2004 (Ardakanian, 2004).

Long-Term Development Strategies for Iran's Water Resources are primarily based on the importance of and coordination among various sectors, which are planning to observe water resources capacity on the basis of sustainable development (Macro Management). These strategies mainly insist on the followings, considering the principles of sustainable development, land use planning and importance of watershed compositions as effective territory in the economic and social development plans (Watershed/Basin Compositions) (IWRMO, 2004):

- Controlling underground water resources exploitation and increasing the utilized share of surface water resources (Water Resources Management)
- Reformation of water consumption pattern (Consumption Management)
- Adaptation of various water consumption management methods, controlling of water consumption and water losses management (Urban Water Distribution)
- Accounting for the national interests and technical, economic, environmental and social feasibility of water exchange (Water Exchange)
- Adaptation of economic development programs to the development projects in each basin, taking into account the economic and environmental value of water (Economic Value of Water)
- Reasonable and efficient pricing of water (Water Supply Costs)
- Water resources pollution management and control (Quality Control)
- Observing national interests and citizen's natural and social rights considering the projects of transferring water between basins and water exchanges (Inter-basin Water Transfers)
- Decentralization of national water resources management structure (Water Management and Structure)
- Preparation for drought and flood management (Risk Management)
- Public awareness programs (Public Training)
- Harness and consumption of joint water resources flowing out, observing economic and environmental standard (Shared Water Management)
- Equipping and completing water gauging networks (Information Management)
- Conservation, reviving and operation of historical water structures (Preservation of Historic Hydraulic Structures)
- Coordination of water supply, distribution, and consumption policies by High Water Council (Interdepartmental Management)

5. Conclusions and Recommendations:

It is significant to note that since the 1979 Islamic revolution, Iran has remained largely outside the paradigm of Western-directed development. Although some Iranians blame the lack of foreign aid and investment for the country's ongoing economic problems, it is at least true that Iran has maintained its independence in the realm of policy-making, making it more successful than most nations in the developing world (Foltz, 2002). Fortunately, the Iranian government has figured out the severe dimensions of the water crisis. Although the steps taken so far have not been sufficient to address the magnitude of the problem, it is not disappointing to observe that they have at least started to take the necessary steps to tackle the crisis.

Obviously, the current water crisis is not a momentary problem and is not the mere product of recent droughts. It should be emphasized that the state planners, instead of thinking about the droughts, should rather be concerned with the water crisis as a continued phenomenon. Fortunately, the Iranian government has realized this point. Although their recent efforts are admirable, they should never disregard that "as they sow, so will they reap". There is an urgent need for Iranians to execute their Water Resources Development Strategies, since these strategies can only be savoured when they are in practice not in theory. Hopefully this time Iranians will carry out their plans with high efficiency and they will suit their actions to their words in spite of the 26-year experience of after the revolution, which has proved the Iranian managers, are not always victorious in implementation of their plans and promises. This failure is mostly due to the existence of many parallel organizations responsible for the same issue. Their new Interdepartmental Management strategy for water resources development is really admirable regarding this issue, which will be definitely supportive in creation of a unique responsible for water resources management in the country.

There is great criticism of the Long-Term Development Strategies for Iran's Water Resources. It seems that the Iranian planners prefer to find a remedy for a crisis rather than preventing the crisis. They must execute risk management instead of crisis management, since prevention is always better than trying to cure. In other words, Iranian water planners have found some counter-measures to the challenges of the crisis but not for its inducers. This means that they could not have inspected the main drivers of this crisis or they have found themselves incapable to counteract the crisis. For instance, it should not be neglected that Population Growth is the main cause of this crisis but the Iranian Water Planners have not compiled any specific strategy to restrict this growth. They have assumed the population growth to be constant and have decided to supply the coming population with enough water. Another example is the other important source of the crisis, which is the migration, and uneven distribution of population, as a result of the unfair distribution of facilities, income, job opportunities, etc. In this case there is no compiled strategy to overcome this issue but to counteract the corresponding challenge of it, which is providing the high-populated cities like the capital with water by massive dam construction or other methods. In fact the water planners in Deputy Minister for Water Affairs of the Ministry of Energy of the Islamic Republic of Iran have one-

dimensional view to this crisis. Perhaps, they have no authority to make a strategy for population and migration control and they are merely responsible for water issues. Apparently, this is due to discrete planning by different authorities of the government body and lack of an integrated arrangement. Therefore it is an urgent need to gather all parts of the government's body together in order to compile such strategies.

Unfortunately, it seems that the environment has not become a great concern for the Iranians, since they have not felt the negative impacts of the coming environmental crisis yet. They have learned to withstand but not to obviate. They continue to build more dams to store water disregarding the adverse environmental consequences. Considering the western worlds unfavourable experiences with massive dam-building enterprises it is somehow disappointing to see the Iranians being so proud of constructing new large dams while neglecting the negative impacts of them on the environment. They have to consider the coming generation's rights and prevent the environmental crisis to be born. Perhaps, altering the current water conservation methods to traditional ones, which are more compatible to the environment (i.e. Qanats) may be a good method to prevent the coming environmental crisis.

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