Using underground dams in resource management

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Abstract: The challenge of conservation, supply and maintenance of water resources is one of the biggest current hydrological issues nationally or even international l ground waters are in fact part of surface water that either make way to the surface through springs, or are extracted from aquifers through wells, aqueducts and soon. these waters are an important source of supplying drinking water that do not require treatment. Therefore, adopting principled and administrative procedures of watershed and aquifer based on scientific basis in order to conserve, utilize and manage water resources play and significant role in reviving underground and natural water resources. Designing a scientific mechanism to extract and feed and ground water supply network without damaging the environment can prevent these resources from destroying, our country. Iran. as one of dry regions with little water needs conservation of ground water resources, and construction of underground dams including aqueducts, traditional aquifers and canals (free aquifer ground water) that has a long history over three centuries, can help optimal utilization of water, conservation of ground water, and preventing drought in the agriculture sector.
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Introduction:

Ground waters are located in a part of surface water either naturally wale way to the surface through springs or are extracted from aquifers through wells, aqueducts, and soon. These waters are one of the most important sources of supplying fresh water requirements, which are generally free from pathogenic organisms and do not need special treatment. ground waters are colorless and without dark matter and also have fixed combination and temperature. generally, ground water is not influenced by short term droughts. in addition, surface contamination does not effect ground water. nowadays, the process of land sinking and changes in water resources quality, falling water table levels of aquifers, and advance of salt water in deserts margin are among destructive effects of uncontrolled utilization of these valuable resources it should be noted that with the increase of population and significant development of industry, the requirement for using ground water resources and the quality of their availability is getting more and more tangible. increasing significance of supplying water in our country makes the use of ground water compared to surface water be specially important as a sustainable source, since these resources, are less subject to changes due to drought and water shortage.

In many countries, significant instances of these dams are currenty underutilization. while this technology hasn't yet been recognized properly in our country and has not been used except for few cases. underground dams are considered for the development of ground water resources and preventing excessive withdrawal of utilizable water, especially in arid and semi-arid areas.

In these areas, ground water is always of special importance because of decrease in the amount of precipitalion and the resulting runoffs, and high evaporation rate. furthermore, poor distribution of precipitation and surface streams during the year may be added, which causes withdrawal of a big volume of water along with portable soils from the basin. using underground dams considering the local condition we can increase the possibility to utilize ground water around 30 percents. this improvement rate especially in arid areas is significant and can have a special role in the area, especially in critical situations.

Underground tanks:

Ground water storage places are divided in to two distinct groups including: 1-aquiters or water collections which are formed in environments with inter granular porosity, and underground thanks which are especially important in terms of utilization, place in this group of thanks. most of these alluviums formed late in the third or fourth geological times. 2-tanks that are formed in fractured layers, especially limestone and dolomite, and also based on the studies in recent years, in masses of fractured basalt. this group of thanks are identified by their hydrologic name- "karstyk"-which instead of forming a vast and uniform aquifer, they form a collection of related gaps that is a passage for water flow.

Status of ground water aquifers:

An aquifer is considered as impermeable layer or area through which water can flow. aquifers are divided in to tw main types:

1-free aquifers: water table level is equal to upper full part, and the pressure in water table level equals to atmospheric pressure.

2-under pressure aquifers: know as "Artisan aquifers" are formed in places in which ground water is confined by an almost impermeable layer from above, and eventually, ground water is under a pressure which is above the atmospheric pressure.

History underground dams:

Dam engineering is an indivisible pat of human civizilation, since dams built for storing and suppling water, are no doubt among most primary structures built by man, and as evidences of Babylon, Egypt, iran,, … civilization show, dams less than five thousand years ago have been used by man, and dam engineering developments have had a close relationship with civilizations ups and downs examples of underground dams-in the actual sence – were built in the first half of the twentieth century and earlier. how ever, development and expansion of underground dams and scientific interference with it, actually began in the second half of the twentieth century and also have growned much in the last three decades. also worth noting is that techniques of using subsurface water flows by means of underground dams first initiated by Iranians in addition the topographic and climate condition of Iran show a high potential in building underground dams. also there is long standing antiquity and importance of the use of underground water in various forms such as aqueducts and canals in Iran. however, there has not been yet continuous and vast studies on underground dams constructions. may be the reason is easy access to surface water and their abundance that caused this important issue not to be well considered. it should be noted that the oldest underground dams in the world have been built located in Meymeh, Esfahan, and near Kashan. the biggest dam amony these. is 9 meters high and has a storage capability about 270 thousands of cubic meters of water that had been used in irrigation and drought periods. Also, a few small dams have currently been built and are being utilized in our country. for instance, Kahnooj underground dams in Kerman province and Haranegh underground dams in Ardakan city. In other countries like Tailand, Tanzania, China, and Brazil, many instances of these dams are under study, execution and utilization.

The effect of underground dams on utilization of subsurface waters:

The method of utilizing almost sustainable resources should loss in various stages of storage, extraction and utilization of water.

In fact we can consider underground dams as a new method for extraction water, especially in hot and dry regions, since in these areas either there is high evaporation ate, and there is the risk of disease or underpass streams get out of access without being used. furthermore, entering fresh [sweet] aquifers into salty water resources, land near seas and swamp on one side, and changes in the quality of underground water while passing on improper geological on the other side, and needing for supply in upstream basins indicate that we should take action in order to control and utilize ground water streams optimally before they get out of access or change qualitatively underground dams are a way for optimal utilization of available resources which not only prevent wasting of ground water, but also their effects on controlling subsurface waters is comparable to the duty of above ground dams to control surface in watercourses.

So that, subsurface water streams can be utilized in due time in accordance with the situation of the project in underground dam riser and in proper lands with more efficiency which are obtained due to the rising of water level in the aquifer.

It should be noted that in point that water is supplied through pumping method in the upstream of the dam, we can transfer water stream to the consumption place without needing for pumping it, and by the way of eliminating wells or case usage of them, we can save the costs of water supply significantly. this is of great importance for place that are faraway and have difficulty using modern technologies. also, in order to prevent withdrawal of aqueduct water in non-irrigation period, we can build dams in proper places along the route and store a lot of water in its upstream.

This method has been applied traditionally in stone parts of aqueducts in some parts of the country, undergrounds can be used to build those aqueducts that suffer from shortage or lack of water due to the falling of water level in the aquifer.

Underground dams, types of underground dams:

Underground dam is a barrier built along the water flow path with the purpose of storing water. the main body of the underground dam is formed of water curtain or a impermeable wall.

Underground dams are divided in to two general types:

A-In terms f position on the ground:1-Buried dams:

1. These dams have walls that are located below the surface, and the tank[reservoirs] is created with in the alluvium.

2-Half-buried dams: In half-buried or suspended dams in addition to one underground tank[reservoir]-can increase their volume of subsurface tank and extend it by creating suspended surface tank and sedimentation of river flow or flood. so, they will also be suitable for flood control. An example of ths type of dams has been constructed and utilized in Japan (Jogin half buried dam).

B-In terms of the type of materials used:

Underground dams divided based on the type of materials used in the body of the dam or geological formations of the reservoir [tank] location. sand dams are an example of this type of dam.

Application of underground dams:

Underground dams are divided in to two general parts in terms of usage: A-underground water storage: In Iran, these dams are constructed for supplying agriculture water, and also drinking water of costal places. But usually due to the law volume of storage tanks and high cost of construction compared to other water constructions, water reguirement of the target areas is much supplied through the transfer of water from adjacent basins. Also, these construction are used for supplying agriculture water, drinking water, as well as artificial feeding. you should note that underground dams are executed in different dimensions and size. so its small dimensions does not mean that it of low importance, and in many cases because they are the only source of water supply in the regions, they are very important and vital. In this regard, examples of dams built in countries like Japan, Brazil, Tanzania and China can be mentioned.

B-prevent saltwater permeation in to fresh water reservoirs:

These dams are usually constructed in coastal areas and Islands.

In these places extraction of ground water is limited or impossible. Among side usages of these dams we can mention lowering the ground water level at downstream points, controlling floods, increasing the quality of ground water, and prevent soil erosion.

The purpose of constructing underground dams

1. Prevent the passing of ground water and with drawing from aquifer.
2. Prevent water wasting and evaporation.
3. Construct a reliable and sustainable storage for water supply
4. construction underground dame in a place contaminants.
5. The possibility of physical-mechanical due to alluvial porous layers under the ground.
6. Preventing soil erosion and the move mend of sediments, and soil stability.
7. Supporting the aquifer and feeding upstream aquifers.

Studies to identify suitable sites for constructing dams

A- Topography of the area:

-underground dame can be built at the exits to plains or at faults

- The best areas for constructing underground dame should include only one ground water outlet passage. These points can be determined using method of mapping the ground water level. Hydraulic calculation of the dam would not go up certain numbers.

-building underground dams in areas with uniform or low topographic slope depends on expending high construction cost.

B-Geology

Lithology: floor and wall stone of the dams reservoir [tank] should be the kind with no permeability. this can be done through geotechnical operation with includes drilling of exploratory boreholes, and "lojan Test" in place where dam is constructed and in the reservoir of the dam, and consistency of drilling lags.

Tectonics: As most gorges and valleys are compatible with dam construction standards in mountan areas created due to orogonic and usually fault phenomena, the target area [region] should be under geophysical studies, and the information of various longitudinal and transverse profiles prepared by identification boreholes are studied and investigated.

Alluvium in dam site: Alluvium permeability, storage ability, and output of the aquifer are basic factors of feasibility of plains due to long distance, decrease of topography, and passing of seasonal and perennial surface flows, faults are usually fine. therefore, and this process should be studied with thickness of the aqueous layer and depth of bed rock in the area, and by drilling exploratory boreholes. factors including thickness of the empty part of the upstream aquifer, the axis of the sediments, and materials of sediments are efficient in storage output and water discharge of aquifers. factors such as the slope of waterway, and outlet cross of the project.

Studies for constructing

Underground dams:

Small U or V shaped valleys are suitable places for constructing underground dame, morphological studies, geology and using geo physic sciences can help determine suitable places for constructing dame. construction vales of underground dame are based building an impermeable wall so as to prevent the withdrawal of ground water.

Determining suitable locations for constructing underground dame is done through geophysical studies, determination of bed rock, determination of alluvial deposits level, Canditions of the aquifer's permeability, stratigraphy studies and lithology [petrology]. obviously, V shaped narrow valleys and mountain waterways overlooking craters are the best areas for constructing such dame. geologically, alluvial layers with low thickness and impermeable layers of bed rock nearer to the surface along with suitable hydrological conditions are the best characteristics considered if finding potentials of underground dame.

Therefore nowadays using techniques of exploring underground resources including sciences of geology, geomorphology, hydrology, geophysics and even remote sensing, not only we can supply water through common methods such as drilling deep wells, semi-deep wells. and aqueducts that lead to extract water from aquifer, but also applying new techniques of engineering and geo technics we can access new sources in order to extract ground water. Thus actual potential share of this sector increases, In addition, determination of technonized fractures and seams, possible landslides and precise determination of hydraulic gradiant route of the ground water and changes in route and it's subsidiary divisions should be determined in studies on selection of the underground dams sites.

A- Preliminary studies: includes collecting information related to arial photos topographic maps geology, information on underground water level balance, anuall bring of ground and surface water in the area, condition of possible floods, information about the precipitation of the area, geophysical tests, geology studies,...

B- Complementary studies: includes information seasonal fluctuation of ground water, drilling boreholes in order to determine depth and characteristics of floor stone, determination of fault thickness, and finally drawing longitudinal and transverse profiles of the waterway. it should be noted that studies conducted while the dam is under construction continue, even after its construction. while constructing the wall of the dam, core taking should be regularly conducted on supports, especially on the place that the dam's wall is conducted to the floor rock.

Numerous experiments should be conducted so as to study the quality of the core and controlling the implementation of the operation and making sure that it is conducted well.

in order to create a proper connection between dam's wall and floor rock, the wall should sink at least 20 cm in the floor rock.

Implementation of the system of the dam or dam's main body implementation of this system is similar to implementation of sealing the base of dams, and it is conducted often and especially in big dams- in two methods, that is injection curtain and the wall of concrete dam. in small underground dams, they use building materials such as sand and cement mother and even geotextile materials as dam agent[factor] in order to build the dam's wall. it should be noted that it is necessary to use high power machinery such as hydrofers, clamshell, grab bocket or powerful ogers in order build dam's walls with big dimensions, this should be considered in feasibility studies and economic studies. on the other hand, preparing proper concrete to fill the dug trenches in a way that while having necessary properties, it could be compatible with different layers of the earth, is very significant and critical, and it need much study and experiment.

Water quality in underground dam site:

on of the most important studies in this regard, is precise in study of water quality in underground dam site.

since, by constructing an underground dam and creating a barrier to the outlet of a basin in a plain:

-In outlets, usually the quality of water is poor and changes in different seasons of the year. so, these projects should be implemented in places where. the quality of water is good for next construction and different seasons.

-The outlets of plains do the drainage for plains. retransferring this water on the same plain or another plain may highly affect the quality of the plains water and soil.

-The water of the plains outlets [exits] also feeds the downstream plains would highly affect the quality of waterthe plain.

Conclusion:

Advantages of the underground dams:

By constructing underground dams in proper areas, it would be possible to store ground water, and prevent it from wasting, without useful usage. so according to type and condition of construction, underground dams could have lots of advantages including the following cases:

1-Water evaporation rate in these dams is much less compared to above ground reservoirs [tanks]

2-If we consider the design concerns and proper implementation, they are more reliable sources for water supply compared to above ground dams. Also, they are less sensitive to droughts.

3-These dams along with other project such as soil projection, preventing erosion, improving water discharge of wells, and flood control can supply many sources.

4-Using reservoir level lands and preventing them from sinking under water in cases of land shortage or high costs.

5-Longer life of underground dams, if they are implemented properly, and necessary points are taken into consideration.

7-Supplying safer water than other water resources(Nowaydays, surface water is more subject to contamination than ground water)

8-Preventing the envasion of salt water of the seas, or entering contaminated water into safe water.

9-The executive cost is far lower.

Disadvantage of using underground dams:

underground dams may have the following **limitations, compared to common above ground dams:**

1-They store less water in their reservoirs.

2-It is very difficult to estimate the right amount of stored and usable water, and it depends on various factors.

3-In these dams, due to invisibility of the work, it is very difficult to control the quality of dam wall construction, as well as draining countler from boundries, and requires much care and study.

4-Maintanance and utilization costs of water extraction establishments is fairly high in these dams.

If the depth dam body is more than 70 meters, the project faces difficulties in terms of implementation and preparing proper drilling machine, and economical issues.

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