An Irrigation System for Arid Regions Based on Cryo-Technology

1. SUMMARY

The revolutionary method of irrigation described below is both a theoretical model and an operational application derived from its essential components - an application which can be verified by computer simulation or pilot field tests.

This new method differs from conventional irrigation systems designed for arid regions in a number of respects. It is based on four essential components: water, energy, carbon dioxide and nutrients. Where an irrigation system, reclamation and new vegetation are being planned scarcity of water will not be used as the primary starting point. Instead, energy and nutrient components will play equally important roles.

The novel aspect of this new system is its reliance on the concept of *energothasis* - that is, achieving energy balance within a specific area. Disrupting energy balance has caused desiccation and desertification throughout the globe and has led to a rise in levels of atmospheric carbon dioxide.

Under the proposed system, energothasis will be achieved by increasing the energy coefficient per unit area using sophisticated cryo-technology.

2 FUNDAMENTAL POINTS

A combination of causes has resulted in a global imbalance in four basic factors of life - water, energy, excess nutrients and carbon dioxide.

2.1 Water

Water exists in nature as vapor, liquid and solid. What's more, its overall cycle on nature has been known in detail for centuries. However, there are no large-scale systems to utilize the potential available within the cycle for transporting water, irrigation and/or desalination.

The Earth's active reserves of fresh water are located a long distance from regions which suffer a shortage of fresh water for use in food production. Yet, there is a plentiful supply of fresh water in various physical states in the Arctic, Sub-Arctic and Antarctic regions.

Nevertheless, the Earth's fresh water supply zone is narrowing alarmingly all the time.

2.2 Energy

Some of the Earth's regions receive more solar energy than they are able to harness, due to strong winds or lack of vegetation. These same regions also possess considerable reserves of oil - that is, inactive solar energy. Most of this oil is consumed by people living in areas with abundant fresh water.

Conversely, over half of the world's natural gas reserves are located in regions with a fresh water supply.

Consumption of all forms or energy is increasing on a global scale.

2.3 Excess Nutrients

Almost everywhere in the world urbanization has created environmental problems. In areas such as the big metropolises, densely populated industrial or intensive agricultural regions excess nutrients have become a problem. Here the nutrient surplus produced cannot be used for local food production or other plant produce.

Eliminating such excess nutrient from the environmental requires a large amount of imported energy, which is obtained from oil-producing countries. Biological oxidation techniques are available, but are not yet in wide use.

2.4 Carbon Dioxide

Current industrial production methods are unable to produce goods and services in harmony with environment. The production of energy has been solved on a global scale, whereas the waste problems caused by industry, urban life and intensive farming have not been resolved on a similar scale. Natural balance has been disrupted and amongst the many consequences has been an increase in atmospheric carbon dioxide.

Accelerated population growth creates a need to increase the production of vegetal mass at the lower end of food chain. However, since there is no feedback on a global scale between, on the other hand, production and the energy input it requires and on the other hand consumption, increased CO2 assimilation through more green plants is required to control the ”greenhouse effect’.

2.4 The Heart of the Problem

Two separated but related issues lie at the heart of the problem.

Current industrial production methods are unable to produce goods and services in harmony with the environment. The production of energy has been resolved on a global scale, whereas the waste problem caused by industry, urban life and intensive farming have not been solved on a similar scale.

Natural energothasis has been disrupted and amongst the many consequences has been an increase in atmospheric carbon dioxide.

Accelerated population growth creates a need to increase the production of vegetal mass at the lower end of the food chain. However, since there is no feedback on a global scale between, on the one hand, production and the energy input it requires and on the other hand consumption, increased CO2 assimilation through more green plants is required to control the “greenhouse effect”.

In order to halt desertification global feedback should be pursued via four essential factors:

Water + Energy + Carbon Dioxide + Nutrients = New vegetation

3. OTHER ASPECTS

Any feasibility study of the proposed system must, among other things, take account of a number of changes in public thinking and in the overall economic situation:

3.1 General Environmental Awareness

In a wide range of economic decisions ecological and environmental aspects are increasingly taken into account, irrespective of whether such decisions affect the entire world, single countries or a region within a country. Decisions on energy which would increase the greenhouse effect are considered undesirable. Saving energy and water is generally approved as a desirable objective.

3.2 Biological Knowledge

Amongst today's scientific community there is an appreciably greater understanding of the multi-layered nature of the biosphere and of the internal dynamics of micro-biological systems than there was before the great advances in these fields made during the 1960s and 1970s.

Significant progress has also been made in the practical application and commercial exploitation of these scientific advances.

3.3 Utilizing Direct Energy

Solar panels have made possible the direct usage of solar energy. A useful life of 20 - 25 years and an efficiency improvement rating of up to 30% means solar panels are a significant primary source of energy, as well as a competitive alternative to schemes based on energy storage and transportability.

Solar panels already production are versatile in application and readily portable so their use increases the chances of making solar energy available.

3.4 Transport Capacity

At present, sources of energy and centers of large-scale consumption are located far distant from each other geographically. Oil is transported from production sites to the points of consumption in ever-larger and safer tankers.

The transport capacity of these vessels is only half-utilized, since tankers are empty on their return journey to oil-producing countries. This free transport capacity could be employed to collect fresh water and/or nutrient-rich liquid waste produced in the industrialized countries. This could be stored in separate containers at oil terminals and shipped to desert areas in oil producing countries for use in producing new vegetation.

Similarly, oil-producing countries and Eastern Mediterranean states could provide liquid waste containers from which the liquids required in implementing the method described below could be collected.

Even single-hulled tankers unusable for oil transportation could be brought into service to help achieve water balance in oil-producing countries and other maritime states affected by aridity.

3.5 Economics

The system described cannot be implemented if it is economically unsound. Under the principles of business profitability as currently applied it is considered more efficient to import oil-based energy to populations in fresh-water regions than it is to utilize local reserves of stored solar energy.

The macro-economic irrigation system outlined here is based on the use of fresh water and involves three aspects of profitability, based on the availability of water and the nutrients required:

1) investment and running costs pertaining to the collection and transportation of fresh water e.g. melting of polar ice/solid-state water, which is easier to transport;

2) investment and running costs for desalination technology pertaining to the production of fresh water from sea water by reverse osmosis and/or the use of solar energy;

3) investments and running costs pertaining to the collection, transportation and biological oxidation of excess nutrients in arid regions.

3.6 Other Relevant Factors

There are a number of other technical and economic issues which it has not been considered urgent to resolve at this stage, but which will be studied during the course of assembling the system.

These issues include details on modeling - for instance, whether computer simulation will be sufficient, or whether a process model in a laboratory environment is required, plus details and results of all experiments to be carried out in authentic circumstances.

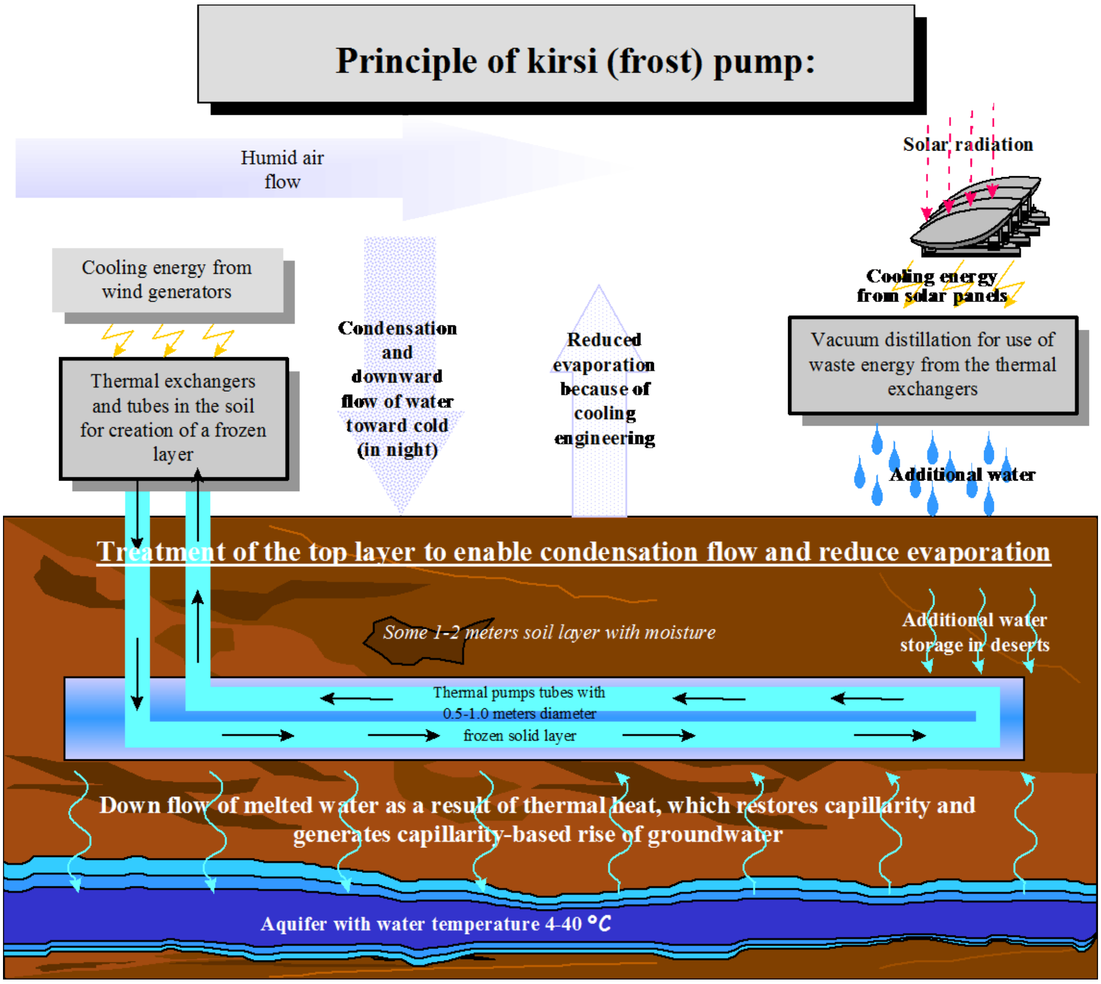
4. A DESCRIPTION OF THE SYSTEM

With the above preamble and general factors in mind it is now appropriate to present a method for a new system for soil irrigation and the production of new vegetation (biomass) in arid regions - SEE DIADGRAM 4.1 BELOW

This method is based on restoring the energy balance (energothasis) of a unit area (sq./meter. Sq./kilometer etc.) using solar and/or wind energy to increase the energy coefficient of the geographical area concerned up to a level prevailing before the onset of erosion, so that after additional input of water and oxidized waste, the area concerned can be used for the phased production of new vegetation in the following manners:

4.1 Structure

On the following page is a short description of kirsi-pump functionality. Solar and wind mill technology are nowadays more feasible as energy source for running such an irrigation technology in real life.



4.2 Implementing the System

The system functions in two distinct phases. Successful implementation of the first phase is a prerequisite for moving to the second phase:

Phase 1

The first phase involves site preparation and creation of frozen layer of subsoil beneath the chosen site, followed by priming. This phase would last an estimated calendar year, in keeping with the biosphere cycle.

Activating the system involves the introduction of the priming components: fresh water imported to the area and mild oxidized nutrient fluid, supported by other methods and auxiliary techniques (biofilm, conventional irrigation technology, windbreaks). Energy for cooling is required at the start and subsequently solar and/or wind energy will be used to maintain the cooled state.

Following activation, the ensuing evaporation process is controlled using energy derived from solar panels and/or windmills. This process will then yield an active microbial flora in the upper soil treatment layer across the area, which in turn is capable of retaining water and energy in the soil layer for subsequent utilization. A special evaporation recovery and collection technique for night-dew will provide the additional water required for the maintenance of the frozen soil layer or water can be fed in from external input.

At the same time, geothermal heat will initiate melting on the lower surface of the frozen soil layer. The melt rate at the lower surface will be controlled using energy obtained from solar panels and windmills. Melting is allowed to continues and additional water is injected until the down-flow reaches the aquifer, thus generating the preconditions for capillarity. This soil layer will likewise obtain its own microbial system in order to establish and then maintain water-retention capacity. The input rate of water containing oxidized waste can be regulated by various incorporated techniques.

This first phase typically work on a system of positive feedback, so that after several operational cycles, increasingly smaller inputs of external energy, water and biological waste are required as the microbial systems in the treated soil layers become independent in line with the normalization of soil-energy intensity.

When this stage is reached the preconditions for the second phase exist, with no artificial irrigation required.

Phase 2

Once first-phase microbial floras and a moist connection to the aquifer are established second-phase activities can be started.

The upper-soil area can be planted with water and nitrogen-binding vegetation. If required, artificial root systems can be introduced initially. Soil capillarity can be enhanced using vertical 'pipelines' of silt, which has good water conduction properties. Pumping technology can even be used to further enhance capillarity. The techniques to be used will be chosen according to soil type and other factors that affect the evaporation rate.

In the second phase continued maintenance of the frozen soil layer will be required because of the salinity of the rising groundwater. Additional water will be required, either from imported biologically oxidized nutrient containing nitrogen and other nutrients, or from collection-points using recovery technology. Additional fresh water will not be required as input, since the rate of water-rise based on capillarity and the water retention capacity of the microbial flora will be sufficient by this stage.

The frozen under-soil layer is established in such a way that during the second phase, when the groundwater rises through restored soil capillarity, the rising water is able to penetrate the still-intact frozen-soil layers. This also acts as a desalination filter where groundwater contains salts. The rising groundwater freezes on the lower surface of the frozen layer and evaporates from the upper surface. In areas where salts dissolved in the groundwater do not present a problem the porosity of the frozen soil layer is ensured either by means of thermally-isolated rhizomes or of holes that are kept open by the thermal energy released in the freezing process.

If biologically more complex plants are unable to thrive at this stage a return to Phase 1 operation will be required in order to raise the energy coefficient per unit area by increasing the size of microbial flora and enhance the water retention capacity of the lower soil layer under treatment.

4.3 Expanding the System

The system can be expanded horizontally by setting up blocs of a defined area which are then provided with the initial inputs and activated. Once the first sites for their irrigation area are able to function without the energy produced by their solar panels, these panels can be re-used, since they currently have a working life of 20 -25 years.

5. OPEN ISSUES

Taking the decisions required to design, install and implement the proposed system requires the discussion of many issues which can be resolved in conjunction with the practical implementation of the system. Such issues include:

- Assessing the required energy and water input into the soil layer to be frozen, the design of alternative structures and operational parameters for water and heat exchangers, ascertaining whether pressurization will be required to feed water into desert soil or whether super-cooling will be needed to freeze and retain water in desert soils;

- technical, biological and micro-biological specifics for re-establishing microbial flora and soil capillarity, such as the choice between a naturally-occurring and varied microbial flora and a culture microbial flora;

- other environmental considerations associated with the introduction of irrigation systems; essential questions include wind prevalence and the effects of wind, floods and heavy rains on the formation of microbial flora, the effect of thermal energy from rainfall on the under-soil cooling process;

- technical, financial, cultural and property issues pertaining to the collection, transportation, transit storage and biological oxidation of nutrient-containing fluid waste produced by urban centers in industrial countries; re-evaluating waste as a valuable commodity.

6. GENERAL COMMENTS

The irrigation system described above is analogous in principle with the system for recovering liquid manure on individual farms in the old agrarian society, which proceeded in an uninterrupted natural state where water and solar energy were concerned. Nevertheless, implementing the present system, relying as it does for start-up on control technologies, with an input of energy, imported water and nutrient recycling all related to global environmental issues, draws on features which can be influenced by some of the following factors:

- after the initial inputs, the system will utilize untapped energy sources such as direct solar and wind energy, which have no adverse environmental consequences and do not increase the greenhouse effect. Indeed, the system will contribute directly to lessening the greenhouse effect;

- current global energy management, food production and waste recycling patterns do not form as closed a system as possible, of the kind which is essential to the unhindered functioning of the biosphere;

- for almost a century oil and fossil fuels have been bulk-transported from one location to another, so fresh water and nutrient-containing fresh water are transportable or purifiable on the same scale if this is necessary from the viewpoint of global economics;

- in future, constructing desert irrigation systems and preventing further desertification, as well as increasing the biomass used for food production, will be essential to the preservation of life;

- a concrete solution to the irrigation and water issue could also provide a positive denominator in arid regions facing desertification by increasing the interaction among the peoples of such regions, reducing mistrust and stimulating co-operation.

7. FURTHER ACTION

This memorandum can be used as the basis for elaborating the idea - by computer-modeling, laboratory scale-models and experiments carried out under authentic conditions. Following this, the likely success of the system in the global environment can be gauged.

While further financial arrangements are sought to support further development, data will continue to be collected concerning expertise on implementing this irrigation method and the availability of such expertise in Finland and other countries, especially those where aridity and desertification pose problems.

Future financing may rely either on public funding, or on the sale of patent rights and, through this channel, the attraction of venture capital. International funding systems and the prospects of using them in the further development of the present method are also being investigated. All initiatives related to potential financing or joint venture arrangement should be addressed formally to the address below.

It is likely that some form of research and development of the idea, with the conditions for membership and the rights of the participants to be negotiated and mutually agreed later. Regions suffering from aridity, poor soil composition and suitability of soil for applying the present method still remain to be determined.

8. INTELLECTUAL PROPERTY RIGHTS

This memorandum outlines the structure and operating principles of an irrigation system which is protected by United States Patent No 5,842,813 and European Patent EP No 95912273.

This memorandum contains intellectual property owned by Mr. Heikki K. Auvinen, managing director and principal shareholder of joint stock company Asumer Oy and protected in this memorandum pursuant to the Copyright Act.

This memorandum with its appendices can in whole or in part, be copied or transformed into various forms or further distributed to third parties with an obligation to mention the source of information. The memorandum does not contain such confidential information possessed by third parties that may constitute a basis for economic or other claims.

9. FURTHER INFORMATION

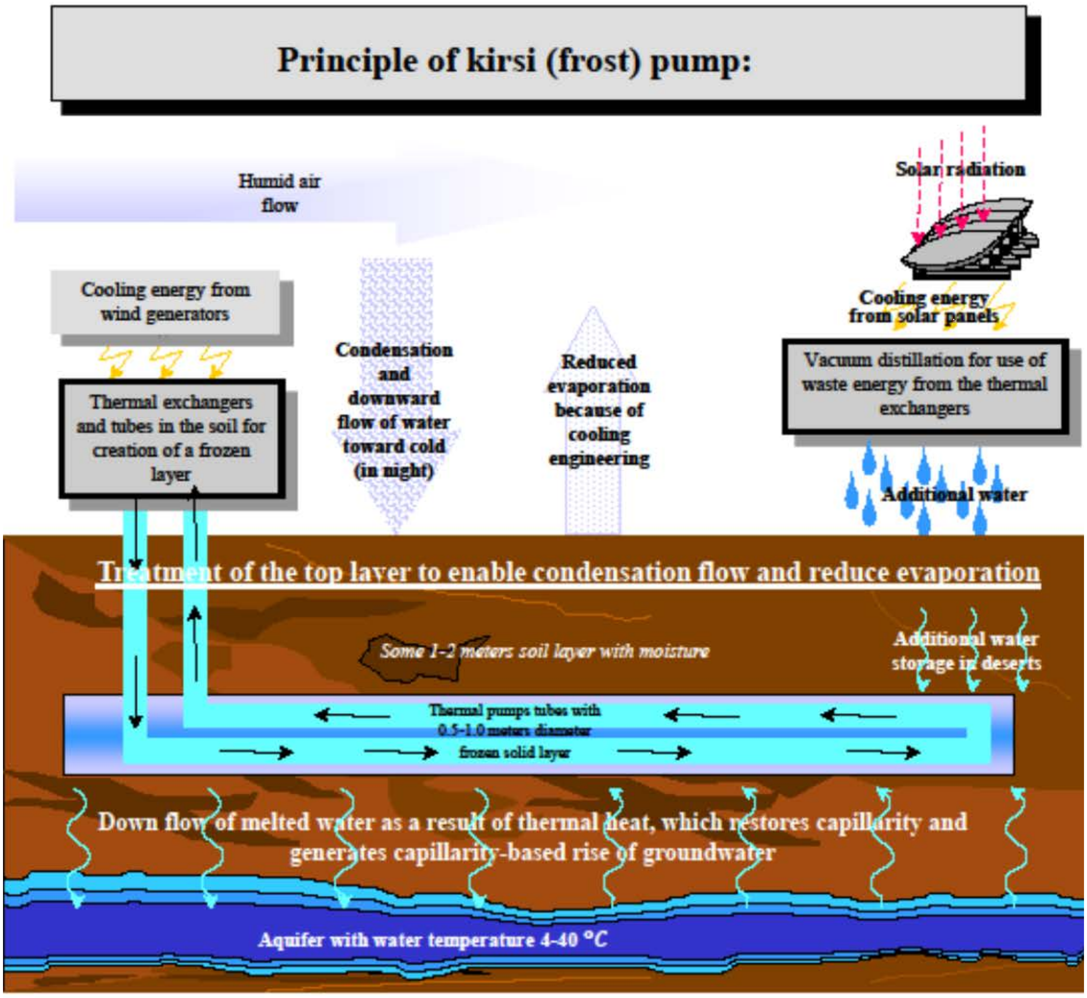
All queries and any further aspects related to this memorandum and method should be sent and forwarded to the following address:

Mr. Heikki K. Auvinen, Managing Director
Asumer Oy
Komeetankuja 4 D 23
FIN-02210 Espoo, Finland
Tel/Fax + 358 400 638 660
E-mail: auvine@hotmail.com

In separate appendices, which can be transmitted by e-mail under a separate cover, it's enclosed the main principle of kirsi (frost) pump as described above in diagram 4.1 of the text and three already developed applications of kirsi technology as follows:

Diagram 1: Principle and basic undersoil application of kirsi technology
Diagram 2: Kirsi technology based groundwater level control system I
Diagram 3: Kirsi technology based groundwater level control system III
Diagram 3: Kirsi technology based desalination system for coastal regions

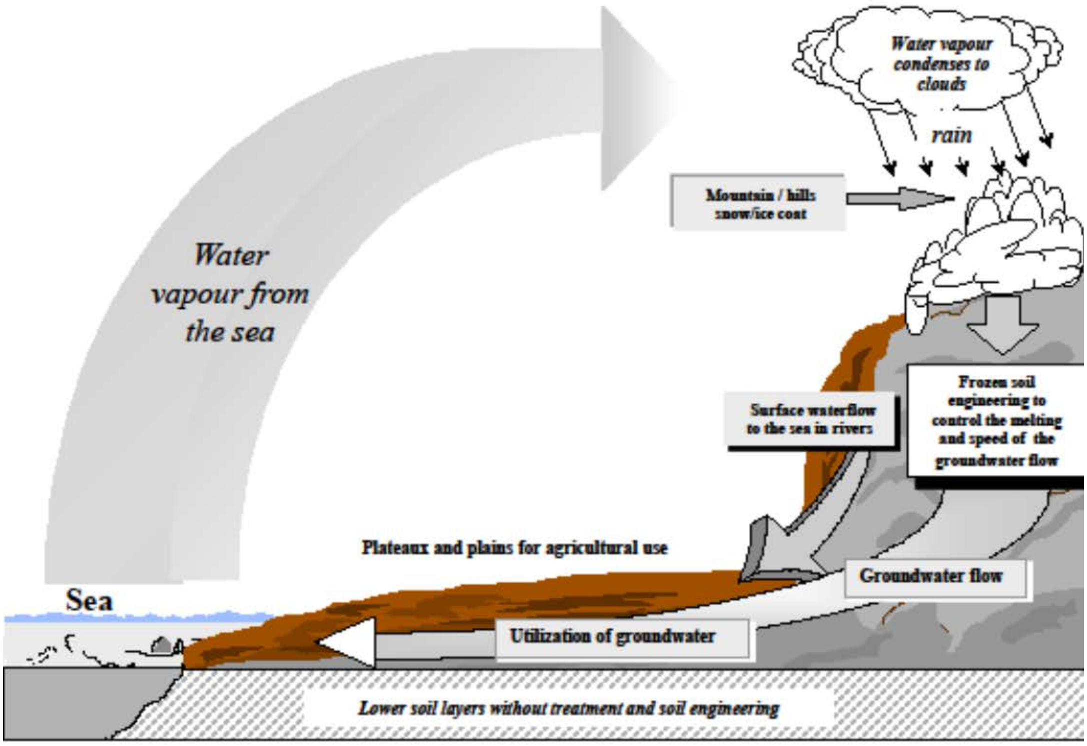
Diagram 1



Water exists in nature as vapour, liquid and solid. What's more, its overall cycly in nature has been known in detail for centuries. However, there are no large-scale systems to utilise the potential available within the cycle for transporting water, irrigation and/or desalination.

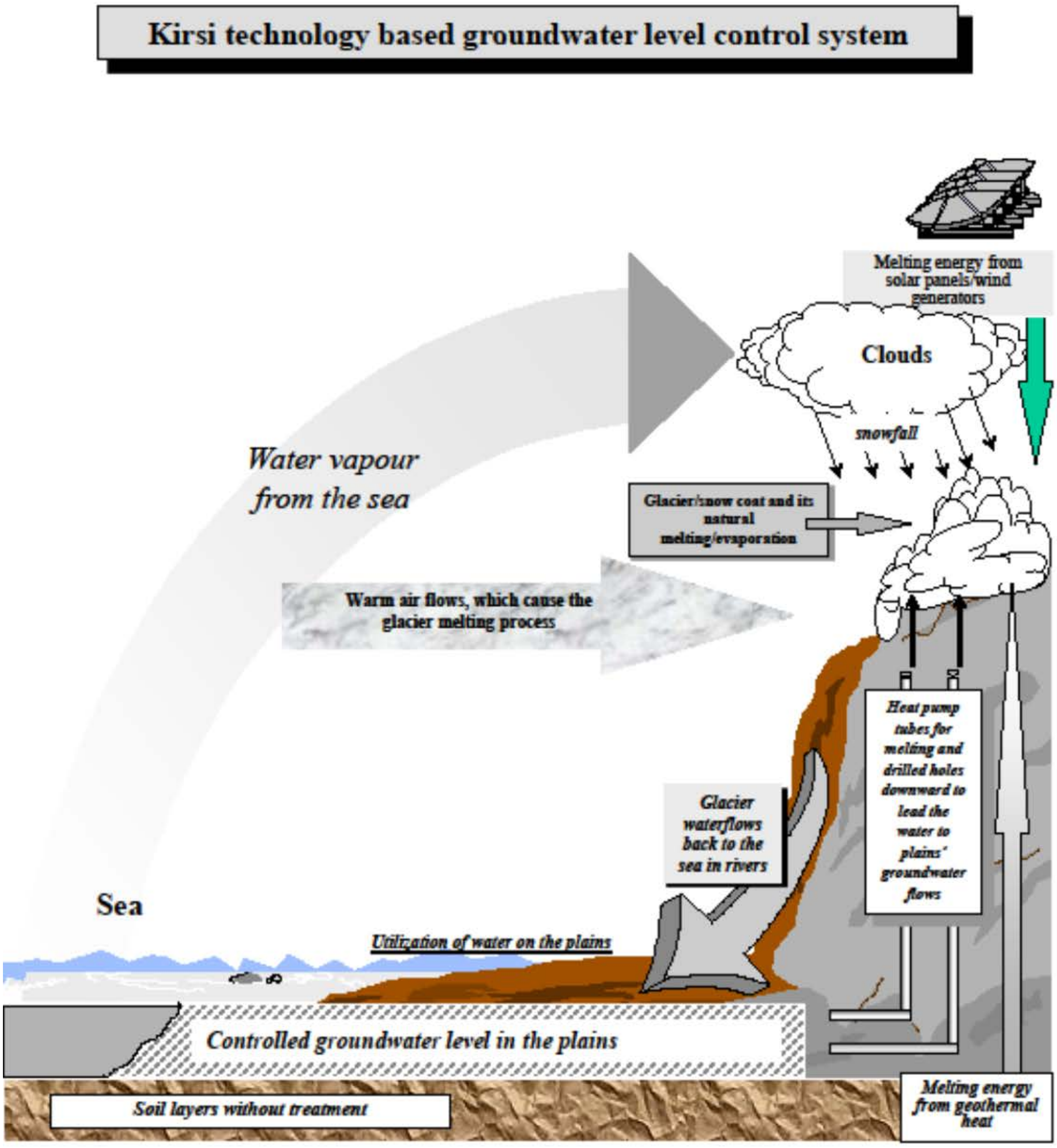
Diagram 2

Kirsi technology based groundwater level control system



Water exists in nature as vapour, liquid and solid. What's more, its overall cycly in nature has been known in detail for centuries. However, there are no large-scale systems to utilise the potential within the cycle for transporting water, irrigation and/or desalination

Diagram 3

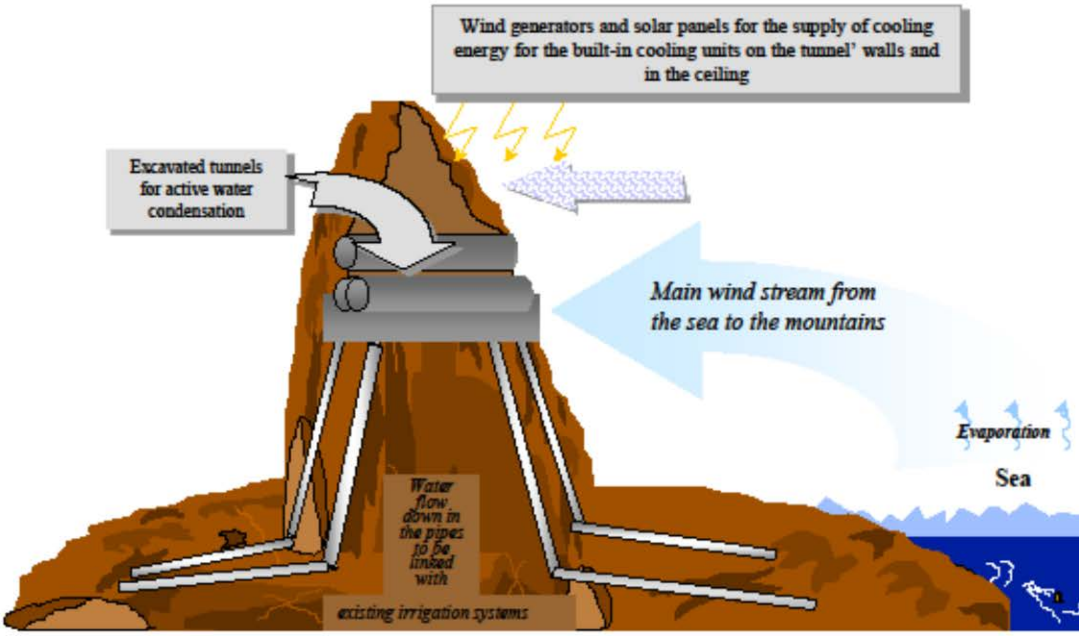


Water exists in nature as vapour, liquid and solid. What's more, its overall cycly in nature has been known in detail for centuries. However, there are no large-scale systems to utilise the potential available within the cycle for transporting water, irrigation and/or desalination.

Diagram 4

Kirsi technology based desalination system

Water exists in nature as vapour, liquid and solid. What's more, its overall cycly in nature has been known in detail for centuries. However, there are no large-scale systems to utilise the potential available within the cycle for transporting water, irrigation and/or desalination.



This proposed new form of desalination will take direct advantage of the water vapour available in coastal regions close to mountains between 2,000 - 3,000 m high where the air temperatures are lower. Compared to existing desalination systems, this new one will use and take advantage of solar energy potential associated with evaporation and also, in the process, change water vapour back into liquid form in (wind) tunnels to be excavated in the mountains, where cooling energy can be generated by solar panels and wind generators. Gravitational power will transport water, using the differential between the height of the liquidation site and the usage sites on the plateaux and plains.