Falling groundwater tables are a worldwide phenomenon. An invisible diminishing of the most elementary fossil resources we use. While the economy is addicted to oil, on the High-energy level it is operating on, life itself depends on water. Plummeting groundwater recources are more than a challenge to the economy, the financial system and a high standard of living – they are the foundation for all of our achievements swiftly retrieving.
Civilisation starts with a working system of food-provision. Only after this is established and effective enough, additional branches of an economy can be developed. But as fossil water-based agriculture dies down Arab countries enter a reverse scenario that leaves the energy crisis a rather petty topic.

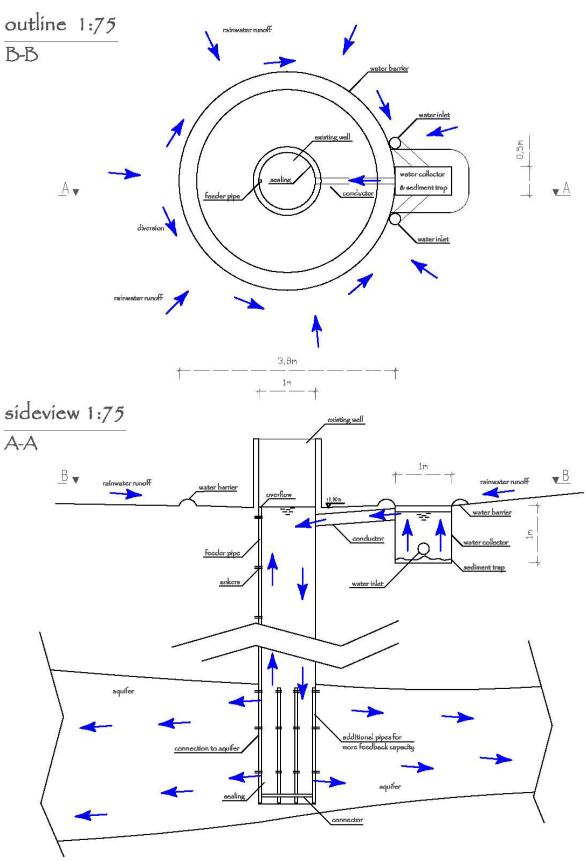
But where are the potent solutions? Inspite of the blue revolution overall waterdemand is increasing more rapidly than all technologies in conservation, reuse or desalination can make up for – watertables are still falling all over the Arabian Subcontinent in the range of meters per year.

There is a potent and deployable solution to stop and eventually even reverse the trend. It was hidden in the area of rainwater management and aquifer recharge so far. An option, rather than a technology utilizing existing wells that have run dry. It was originally designed by TS Prototype Creation as a developmental aid project for Niger and an engineering challenge to create the most cost-efficient solution for rainwater management possible. The solution in a nutshell:
Dry wells can be reactivated as cisterns and Aquifer Storage & Recovery units (ASR).

Traditional wells are at the bottom of watersheds and allow for filling without the necessity of pumping. The entire area around the well could be modified and serve as a funnel to collect the short, but massive rainfalls occuring in the deserts of the MENA region. Drainage ditches aid in speeding up the flow.

Simple structures on the surface, to slow down the water and to keep back surface sediments, aid in collecting clean water. The excess water is drawn from top of the filled cistern-well and introduced back to the natural aquifer where the water once came from.

The performance of this solution is excellent because the geological aquifer will, in most cases, lead the water back to the well bottom. It will not likely vanish in subterranean canals as it might happen if water is just introduced anywhere.



The solution is more than sustainable. It is a selfsufficient and sustainable reclamation utility that does not even require significant maintenance - just like a tree. It could be compared to a Palm Oasis because a large surface area receives a rainwater management system. The difference being that water is stored securely underground and the system is fully up and operational from the first rain event on.

Further more the RW shows a positive Material-input per service-unit (MIPS) displaying the true character of the solution.

An RW does not aim at quick financial profit, but is a stable process to recreate Life Support Systems (LSS). These are the foundation of our economy and a prerequisit for financial profit.

Injection wells are nothing new, but retrofitting and activating a barren open-well, utilising it as a cistern and filtrating the runoff water for aquifer recharge is. Even the practise of recharging aquifers alone is hardly found anywhere in the world. Some of the few examples are implemented in Bangalore[1] and soon the strategic water-reserve which is being built in Abu Dhabi currently.

Injection wells are commonly used to deposit waste water, or even hazardous effluent from factories. The idea of putting a valuable comodity into the uncontrollable, unaccessable ground we`re standing on is a paradigm change.

The U. S. Environmental Protection Agency (EPA) groups injection wells into five classes, depending on the type of waste to be disposed in them:

- **Class 1**: receives industrial, commercial, or municipal waste fluids injected beneath the lowermost formation containing an underground source of drinking water (USDW) within 1/4 mile of where the well was drilled. Class 1 wells are prohibited in Washington State.
- **Class 2**: receives fluids that are brought to the surface as part of oil or natural gas exploration, recovery or production.
- **Class 3**: used for mineral extraction. 2 basic types: solution mining and in-situ leaching for minerals. Class 3 wells are prohibited in Washington State.
- **Class 4**: receives radioactive or hazardous waste injected into or above underground sources of drinking water. Class 4 wells are prohibited in WA State except for Class IV wells used at an approved Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) or Resource Conservation and Recovery Act (RCRA) facility that reinjects treated ground water into the same formation.
- **Class 5**: all other injection practices not included in the other classes. Class 5 injection wells, the most common injection well in our state, are generally shallow wells used to discharge fluids into or above a ground water aquifer. In many cases, these aquifers are shallow, unconfined or surficial. Large on-site septic systems, serving 20 people or more per day or having a capacity of 3,500 gallons per day, are considered Class 5 wells.

The wider neighbourhood of RWs is spotted with various practices and techniques of groundwater- or aquifer recharge through surface percolation or injection[2]. On the

[1] "Percolating young minds: Case study of recharge wells dug by an educational institute" by Shree Padre Dec,2007

[2] The Groundwater Recharge Movement in India, by RAMASWAMY SAKTHIVADIVE

7th International Symposium on Managed Aquifer Recharge in Abu Dhabi mostly the very costly injection technology was the topic.
In contrast the unique advantage of RWs is not recharging or storage but a way to harvest the tremendous amounts of otherwise lost rain.
A major difference between recharge by percolation and RWs is the amount of evaporation on the water surface which is dramatically higher if the rainwater is not directly forwarded underground.

Another difference is the quality of water. RWs provide clean drinkingwater in the cistern, right after the rain event. Only after the well shaft is full the excess water will percolate into the aquifer to the sides. RWs are about drinkingwater, which is the most important type of water. The quantity and quality of water in an RW is layed out for highest security and purity in drinkingwater utilities.
To cover the drinkingwater demand for one person for one year in an arid desert environment a rainwater catchment area of only 14m² suffices (with an annual precipitation of 100-110mm like in Riyahd and 4L per day).

The secret of RWs lie with the collection of rainwater. Finding the right method of converting the desert-surface into a funnel in combination with the right location and subsequent resettlement efforts to maintain the unit.

All of this is still talking reactivating dry wells. The situation in the (new) urban areas, particularly close to the Hajar mountains and with lots of sealed surface is different. In these ares new RWs, built in the exact same manner, reach payback quicker and with less maintenance required. In these areas RWs could even help solving the problem of floodings which occurred recently and might be a sign of change. The Musandam peninsula has become hopefull of receiving more (Monsum) rain in the future due to climate change. It would show a high measure of foresight if these simple measures were taken to work towards this prospect. Stability is what investors look for today and that`s what a region with a grit of RWs will exhibit.

The Dilemma

The problem with Aquifer Storage and Recovery (ASR) is that it is developed by scientists who desire to excel in their skills. No game is more exciting to a man than scientific engineering. The specialist wants to apply all available data and formulas, engineer hydrogeological models and achieve to get paid for the most costly planning process possible.
But the models frequently turn out to be wrong, particularly in the natural sciences were models are based on countless assumptions and results are erratically different due to plenty of levers in the calculation which are suspect to personal choice making. Stunning examples of it can be read in the specialized press every day.
Understanding climate or geology will always be a partial matter and can not be controlled like e.g. steel-alloys in mechanical engineering or structural analysis. This is a truth that is highly elusive to the investor. The transposition of our trust in technology unto natural sciences could turn out as one of the most momentous errors of our time. Probably the best example in modern history has just occured in Japan: Engineers simply took wrong assumptions about geological events, although they were otherwise fully qualified, able to built a highly complex machine and to operate it successfully over a longer period of time.

Another downside of industrial ASR solutions is the ratio of investment to recharged water unit, or retrievable water unit. This ratio can never be as good as the recharge into a formerly operational well and its appendant, proven aquifer. **On top of that RWs can be operated without any machinery, fossil energy, water or lubricants.**

The stategic reserve in Abu Dhabi was contracted to be built for $430m first. One cubic meter of the injected water costing $26, only counting the construction. RWs can cost 7 orders of magnitude less. Nevertheless the amount of water that can be stored through the RW is principly limitless just like it is with an ASR. Both technologies are simply access methods to the vast underground reservoirs which are probably interconnected throughout vast portions of the Arabian Subcontinent according to most studies. The question of recovery in turn, has many questionmarks in both cases and only the cisterns of RWs are exempt from these insecurities.

The lifespan prospect of a delicate ASR, which is crucially dependent on a certain company to operate it, looks very dim compared to an RW which will be passed on from generation to generation, empowering a people to be self-reliant and reclaim their land step by step.

Dry well in a plain that could be transformed into a vast rainwater catchment area