Saturday, February 1, 2025

Hi Yohan, Leslie, and Jason,

We should propose to store water run-off from mountain areas in a natural or made-made aquifer like the proposal below. The water run-off is not contaminated like water from the urban streets. Pacific Palisades and Altadena have an abundance of mountain run-off. I witnessed the vast volume of water run-off of the Arroyo Seco near JPL during one major rainfall in 2011.

The Beaumont Water District near Palm Springs CA already pumps water run-off from mountain slopes into an aquifer. They sell the water to adjacent regions. The water that is stored underground will not evaporate like an above ground reservoir.

We can use solar power to extract the water to fight fires or to use for irrigation. Each region can have their own natural or man-made aquifer. This is a better alternative than using a swimming pool because more water can be stored and because it will be resistant to evaporation.

Here is my original proposal to JPL Future Vision in 2013:

" A 2009 publication for the Natural Resources Defense Council (NRDC) concluded that management of groundwater is crucial· for the future of California: http://www.nrdc.org/water/lid/files/lid_hi.pdf.

Groundwater management is crucial for most global regions. Much of the problem of obtaining

groundwater is due to impervious surfaces associated with urban sprawl. Conventional storm water systems are designed to move water into storm drains as quickly as possible.

In California, the storm drains carry potable or nearly potable water to the ocean. The same publication proposes that storm water management be done by imposing strict requirements upon new land developers by imposing more porous surfaces in urban designs. This approach only deals with new land use. JPL should apply its diverse mixture of engineers and scientists to apply their knowledge, skills and technology toward water management, a critical service for a global economy. Storm water could be better managed and monitored by the development of more Aquifer Storage and Recovery (ASR) systems. These systems store storm water underground in existing aquifers for later recovery.

Further development of remote sensing for groundwater using JPL's GRACE satellite data and the development of methods to inject storm water into aquifers should be in JPLs future goals. JPL should use gravimeters (gravity meters) as an in situ, secondary means of verifying the presence groundwater computed by the GRACE Terrestrial Water Storage (TWS) and Land Data Assimilation System (TDAS) soil models. JPL should conduct remote sensing efficacy study by comparing gravimeter measurements to monitoring well measurements as a means to validate (in situ) remote sensing (gravimeter) approach.

JPL's future should include joining or forming a drought mitigation consortium that partners with universities, earth scientists, geologists, engineers, hydrologists, and other agencies such the California Department of Water Resources (DWR) , the National Drought Mitigation Center (NDMC), the USDA etc. that have common or complementary goals of harvesting, monitoring, or management of rainwater."

Blessings,

Jerry

The recent fires in SoCal reminded me of a storm water management proposal that I made to NASA back in 2011.

(See attachment 1)

NASA recognized the storm water management objectives in their Grand Challenges for Future Vision in 2013 when I suggested it.

Saturday, February 1, 2025

(See Last 3 pages of attachment 1)

The Malawi outreach includes strategies for storm water management also.

Storm water management should be part of the STEM with a mission discussion.

https://solar-solns.com/Solar_Powered_Water_Pump_Malawi.MP4

https://solar-solns.com/Womens_Empowerment_Solar_Pump.mp4

NASA Innovation Initiative

Application of NASA capabilities to mitigate drought conditions of Western States

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Water is imported into SoCal while Tens of billions of gallons of runoff flows into Pacific Ocean during storms

The L.A. River cascades under the Anaheim Street bridge on its way to Long Beach Harbor. Tens of billions of gallons of runoff went into the Pacific Ocean. (Brian van der Brug / Los Angeles Times / December 23, 2010)

- "…conventional stormwater controls aim to move water off-site and into the storm drains as quickly as possible…" (Chau, 2009)
- Captured stormwater could reduce SoCal dependency upon imported water. (Boxall, 2010)
- Water dumped in ocean from recent storm could supply water for over 130,000 homes for one year. (Boxall, 2010)

Rainwater Capture

- "Both the snowpack and surface runoff that form a critical supply of potable water for western states are being affected by higher temperatures." (Chau,2009)
- "Low impact development, or LID, is a land planning and engineering design approach to stormwater management that enables cities, states, and individuals to increase access to safe and reliable sources of water while reducing the amount of energy consumed and global warming pollution generated by supplying the water." (Chau,2009)
- "LID was developed to ameliorate"… "or eliminate—the pollution and erosion problems generated by runoff from urban and suburban development at the source, where rain falls on paved surfaces, by maximizing the natural onsite infiltration and treatment abilities of soils and vegetation or by capturing water for later use." (Chau,2009)
- The EPA has set guidelines for local municipalities to implement LID in urban areas

Why Groundwater is Preferred

- "In California, water systems account for a staggering 19 percent of total electricity use and about 33 percent of non-power-plant natural gas use. A significant portion of the electricity is used in the conveyance of water" (Garrison et al, 2009)
- "…ocean desalination requires an estimated 4,400 kWh/af to supply potable water. Improvements in desalination technology have lessened the amount of pumping energy required for this process, but high energy intensity is still an issue…" (Garrison et al, 2009)
- "…Even with advanced treatment to remove salts and other contaminants, recycled water and groundwater (the Reuse and GW columns in Figure 7) usually require far less energy than imported water (CO River and SWP) and seawater desalination (Desal), as does capture and onsite use…" (Garrison et al, 2009)
- "California is the nation's largest producer of groundwater, extracting nearly twice as much as the next state, Texas." (Garrison et al, 2009)

Distinction between capture methods

- Current flood control sends excess water to storm drains to avoid flooding conditions
  - Some water is held by dams and released periodically to spreading grounds to allow water to percolate into aquifers (Kimitch, 2010)
  - "Conventional methods of aquifer recharge (AR) include surface spreading, infiltration pits and basins in addition to injection wells. Injection wells are the selected method of artificial recharge in areas where the existence of impermeable strata between the surface and the aquifer makes recharge by surface infiltration impractical or in areas where land for surface spreading is limited." (EPA Underground Injection Control, 2010)
- Low Impact Development (LID) "…emphasizes the use of smallscale, natural drainage features integrated throughout the city to slow, clean, infiltrate and capture urban runoff and precipitation, thus reducing water pollution, replenishing local aquifers and increasing water reuse…"(Chau, 2010)
  - LID practices that emphasize harvesting rainwater, or redirecting and collecting runoff for beneficial use, include two general categories of techniques: use of infiltration to recharge groundwater supplies, or capture for onsite use.
  - The goals are to decentralize & manage urban runoff to integrate water management throughout the watershed, Preserve or restore the ecosystem's natural hydrological functions and cycle, Account for a site's topographic features in its design, Reduce impervious ground cover and building footprint, Maximize infiltration on-site.
- "Aquifer Storage Recovery (ASR) is the storage of water in a well during times when water is available, and recovery of the water from the same well during times when it is needed. Storage zones range in depth from as shallow as about 75 m (200 ft) to as deep as 900 m (2,700 ft). Many also use ASR for water banking, storing water during wet years and recovering it years later during extended droughts." (Pyne, 2010)
  - "While an aquifer recharge (AR) well is used only to replenish the water in an aquifer, ASR wells are used to achieve two objectives: (1) storing water in the ground; and (2) recovering water (from the same well) for a beneficial use."(Codrington, 2009)
  - "There are 1,185 AR and ASR wells in the United States…" There are 248 AR/ASR wells in CA alone. (EPA Office of Ground Water,2009)

Shortcomings of the capture methods

- Conventional methods
  - Wastes volumes of potable water to storm drains
- LID
  - LID is for new developments only
  - LID has no plans for existing watersheds
  - Urban areas are covered with impervious surfaces
    - Retrofitting urban areas to comply with LID is costly, and unlikely
    - Rainwater will continue to be wasted in urban areas in foreseeable future
- ASR wells
  - Some states require that water used for ASR injection be potable water or drinking water treated to national or state Drinking Water Standards or state ground water standards (Codrington,2009)
  - Requires knowledge of geological features to locate aquifers
  - Requires core drilling to create well
  - May require a large number of laterally distributed wells to define, and monitor the aquifer. (BCVWD,2008)
    - "This can be financially prohibitive" (Endres et al, 2000)
  - ASR wells are sometimes located very deep (2700ft) below the ground surface (bgs) [Pyne,2010]

Why ASR Method is Best for Urban Areas

- ASR wells offer a remedy for the lack LID planning for rainwater harvesting in existing urban watersheds.
- "Large amounts of excess water are present during the winter months; yet during summer, increased consumption of water for the rapidly growing population strains the water supply. Surface reservoirs use valuable land needed for development or the preservation of open space and can have an annual pan evaporation loss of 1.5 m of water …. In addition, this method of storage is not always viable economically for the local community because the cost of construction and maintenance of such reservoirs can reach tens of millions of dollars. The aquifer storage recovery ASR process Pyne, 1995 provides an alternative and affordable management approach to the water supply needs in this region because it utilizes an underground reservoir, and surface space is not required."(Davis et al, 2008, Water Science and Technology Board, 2008)

Application of NASA Capabilities to Develop ASR wells for water storage

- JPL has technology and experience to assist in ASR well development
- Ground Penetrating Radar (GPR) may be used to define the aquifer structure and boundaries. (Endres et al, 2000, Asprion et al, 1997)
- JPL's knowledge of radar may be used to develop science of reading aquifer geological features (Heggy,2011)
  - Data from radar maps can reveal aquifer structure non-invasively.
    - A local ASR team recently drilled lateral wells to monitor an aquifer (BCVWD, 2008)
    - Radar scans can reduce cost of ASR well planning and rainwater management
- Radar scans and mapping could help to predict the maximum rainwater flow rate that can be injected into the well , the specific yield, the storage capacity, etc.
- Radars maps can be correlated to aquifer sedimentation and porosity. (Asprion et al, 1997)
  - Hydraulic modeling tools can be used to translate aquifer geological features to injection flow rates and capacities for urban areas (BCVWD,2008)
  - Projected aquifer injection flow rates are useful for forecasting, planning to minimize risks before sizable monetary and manpower investments.
- Time Lapse microgravity surveys of an ASR well located 300m below ground surface have been used to detect the distribution of injected water as well as its general movement. (Davis et al,2008)
- Gravity anomaly knowledge gained from the JPL's Gravity Recovery And Climate Experiment (GRACE) could assist in time lapse microgravity surveys of aquifers

Proposed Funding Sources

- The Department of Water Resources (DWR) has an outstanding Proposal Solicitation Package (PSP) for stormwater management that is due Friday April 15, 2011. (DWR, 2010)
  - DWR PSP goals are groundwater recharge, water quality improvement, ecosystem restoration, reduction of instream erosion and sedimentation, etc.
  - Only local agencies and non-profit organizations qualify for DWR PSP

Proposed Funding Sources

- JPL has another non-invasive inspection task with the DWR to do research of estimating snow pack in Sierra Mtns using satellite data
  - A similar program for using GPR could be proposed.
- The EPA offers grants to do research on stormwater management

NASA Team Development

- We envision a consortium of team members/agencies to execute the proposal
- Assemble team to write proposal to applicable funding sources
- Include the following team members
  - A hydrogeology scientist
  - A Ground Penetrating Radar (GPR) Specialist/Consultant
  - A thermal-hydraulic modeling specialist
  - An aquifer Storage Recovery Consultant/Specialist
  - A local Pasadena municipality i.e. a water management agency to establish a developmental site.

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JPL Grand Challenges

May 2013

[redacted]

Top 8 (in no particular order)

- Discovering and Exploring New & Habitable Worlds Both in Our Solar System and Beyond
- Robotic Explorers Across Our Solar System
- Observing and Protecting our Planet
- Universe Origin & Evolution
- Partners with Human Exploration
- NEOs and Space Debris, Space Manufacturing
- Swarms, Distributed Systems
- Interplanetary Communications Web

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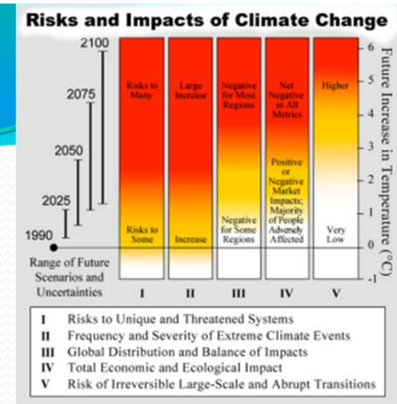
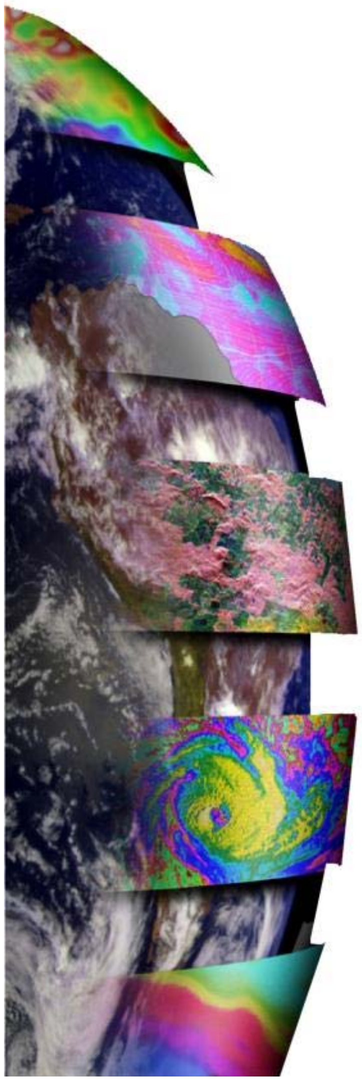


Observing and Protecting our Planet



- Lead in leveraging diverse and complementary satellite (and other) observations to understand and predict Earth's climate and its anthropogenically-induced changes
  - Incorporating diverse observation strategies (temporal and spatial frequencies, cooperative networks)
  - New observations that better measure human impact

- Key challenges in the next 20 years
  - Integrating data from multiple sources with varied characteristics (e.g., sampling, uncertainty) to improve overall understanding of the Earth system
  - Using data sources to provide tangible societal benefits (e.g., management of water reservoirs, GHG emissions)
  - Develop new space-based technology for non-fossil fuel based energy generation (e.g., beaming power from space)
  - Provide technical evaluation of proposed geo-engineering concepts

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