

# AN OPTIONAL APPROACH FOR FLOOD MITIGATION AND AVOIDING GROUNDWATER DEPLETION IN THAILAND: A REVIEW OF THE CONJUNCTIVE WATER MANAGEMENT

SOONTHORNNONDA PURIPUS<sup>1,\*</sup>, CHUENCHOOKLIN SOMBAT<sup>1</sup>, TANTANEE SARINTIP<sup>1</sup>, EKKAWATPANIT CHAIWAT<sup>2</sup>, RASMEEMASMUANG THAMNOON<sup>3</sup>, SETHAPUTRA SACHA<sup>4</sup>

## Introduction

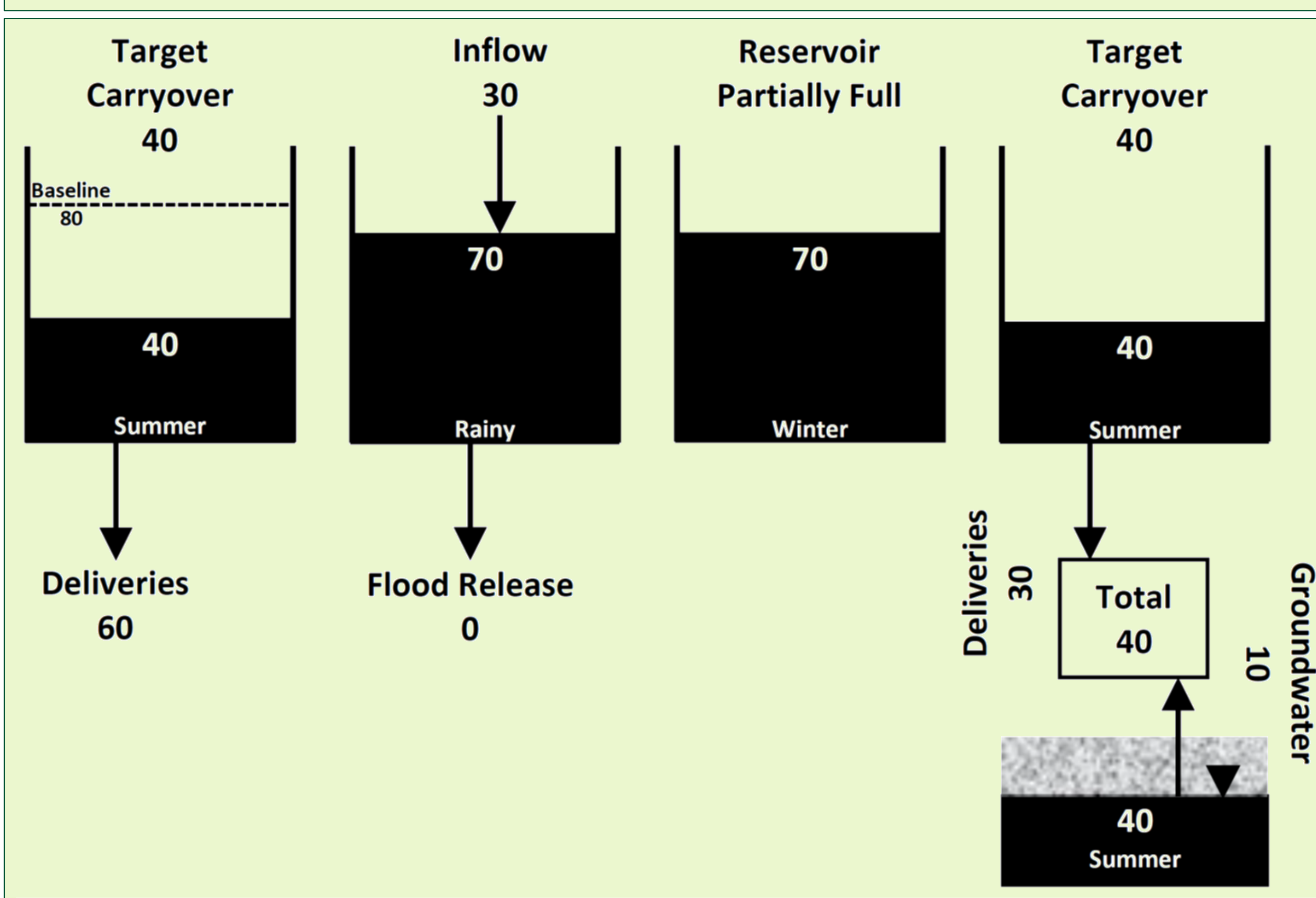
The challenges of climate changes and population growth are quite formidable. Conjunctive use, groundwater banking, and re-operation of reservoirs could exhibit physical capacities of adapting to significant changes in both climate and population (Tanaka et al., 2006). Conjunctive water management of surface water and groundwater would be able to minimize flood risk and recharge groundwater basins while also improving ecosystem functions (Public Policy Institute of California, 2011). Thailand has to seek for new measures to enhance the ability of controlling water in order to mitigate problems of floodwater and lowering of the water table. These problems have tended to make serious threats to Thai people during the last decade. Fortunately, physical characteristics of the country's natural groundwater basins are helpful for orchestrating the conjunctive management of surface water and groundwater.

## Possibilities of Thai Conjunctive Water Management

### Growth of Social Interest

Several studies in Thailand indicated that the implementation of conjunctive uses is possible (Pavelic et al., 2012), and should be emphasized for agricultural areas (Jampanil, 2003; Bejranonda et al., 2006). However, the full potential of this conjunctive management approach for flood mitigation and avoiding groundwater depletion would certainly require multi-purposes of reservoirs. Then, it only needs to be accomplished by reservoir re-operations. Other findings based on several studies elsewhere (Philbrick and Kitanidis, 1998; USACE, 2002; NHI, 2011; Burley, 2012) reaffirmed that most major reservoirs can be re-operated to reduce flood risks, prevent or slow groundwater depletion, and buffer the effects of climate change.

A Concept of Reservoir Re-operation in Conjunction with Groundwater Aquifers (Adapted from NHI, 2011)



## Context-specific Approach for Thai Conjunctive Water management

**Reservoir re-operation** in conjunction with groundwater aquifers can increase reservoir space to capture inflow during flood season. In Thailand, the short winter will be followed by hot and dry summer. During summer period, it will be the right time to use more reservoir water, and then the reservoir will have more space to catch precipitation during rainy season. The conjunctive uses should also be applied during this season. More consumptions of surface water during summer will appear to be the in-lieu groundwater recharge. After summer, the rainy season comes. This runoff event is normally the proper time for recharging groundwater storage thru seepage and infiltration.

## Sustainable Knowledge of Thai Conjunctive Water Management

In order to pave the way towards sustainable knowledge of Thai conjunctive management, the institutional development of Thai water-related agencies should come first. At present, several water-related agencies with similar missions are under different ministries. It is always harder than it seems to complete one substantial implementation of water-related best management practices. Even though regional integrated groundwater and surface water planning have been studied for some years ago, it primarily focused on the conjunctive uses.

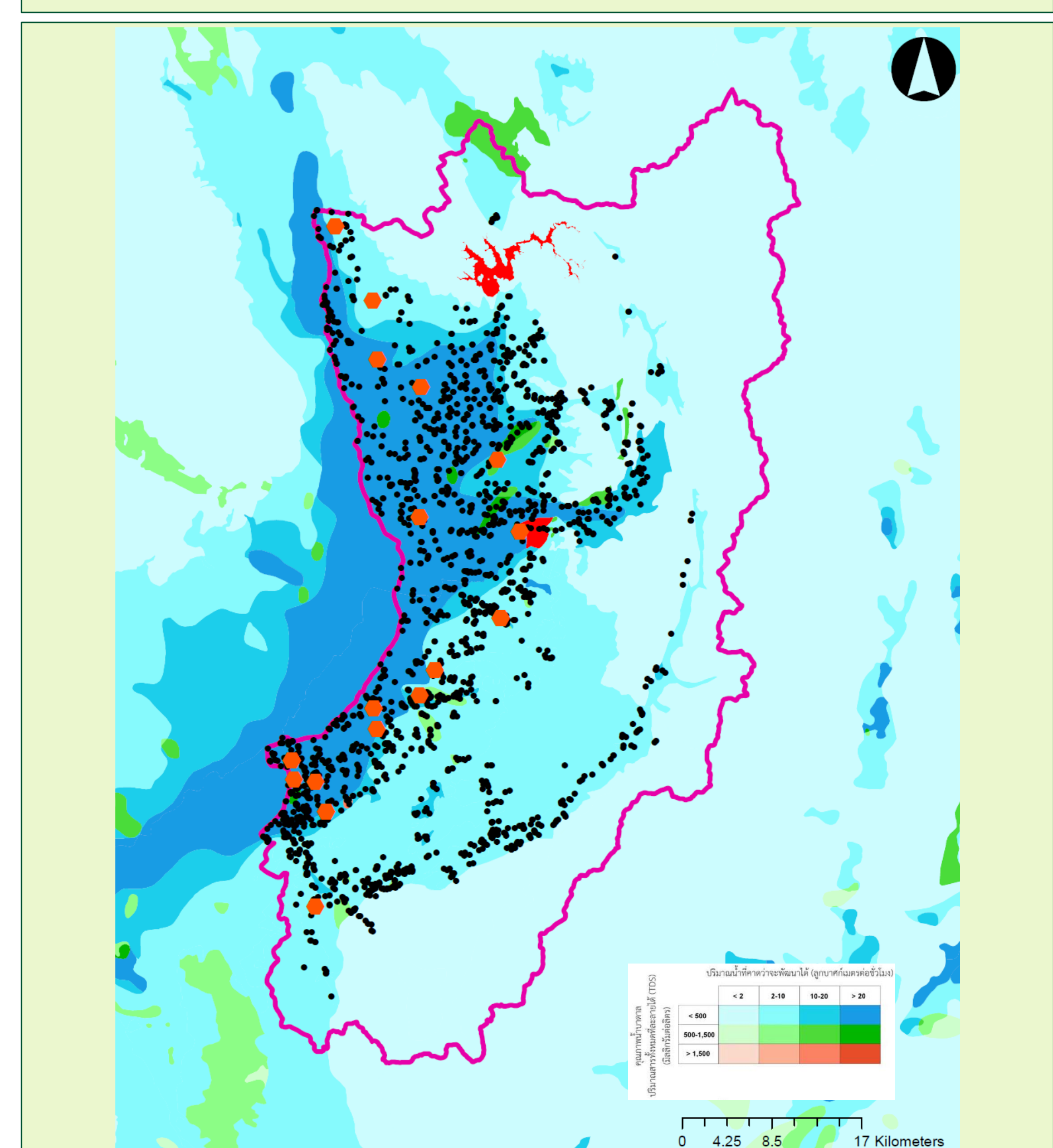
Secondly, the first feasibility investigation of re-operation of pilot reservoirs in conjunction with groundwater systems for flood mitigation and avoiding groundwater depletion should be applied. This investigation should also contain the profound study of groundwater and surface water interaction in the reservoir using water-budget analysis. Thirdly, the comprehensive model of this conjunctive approach has to be constructed and validated. It is necessary that the model closely mimics the real reservoir re-operations and follow practitioners' suggestions. In addition, the groundwater phenomenon may have to be taken into account. Lastly, the technical manual of this conjunctive management approach for flood mitigation and avoiding groundwater depletion for decision makers should be well prepared. This manual will clearly illustrate the data interpretation. It will also provide decision-making options and recommendations.

## Conclusions

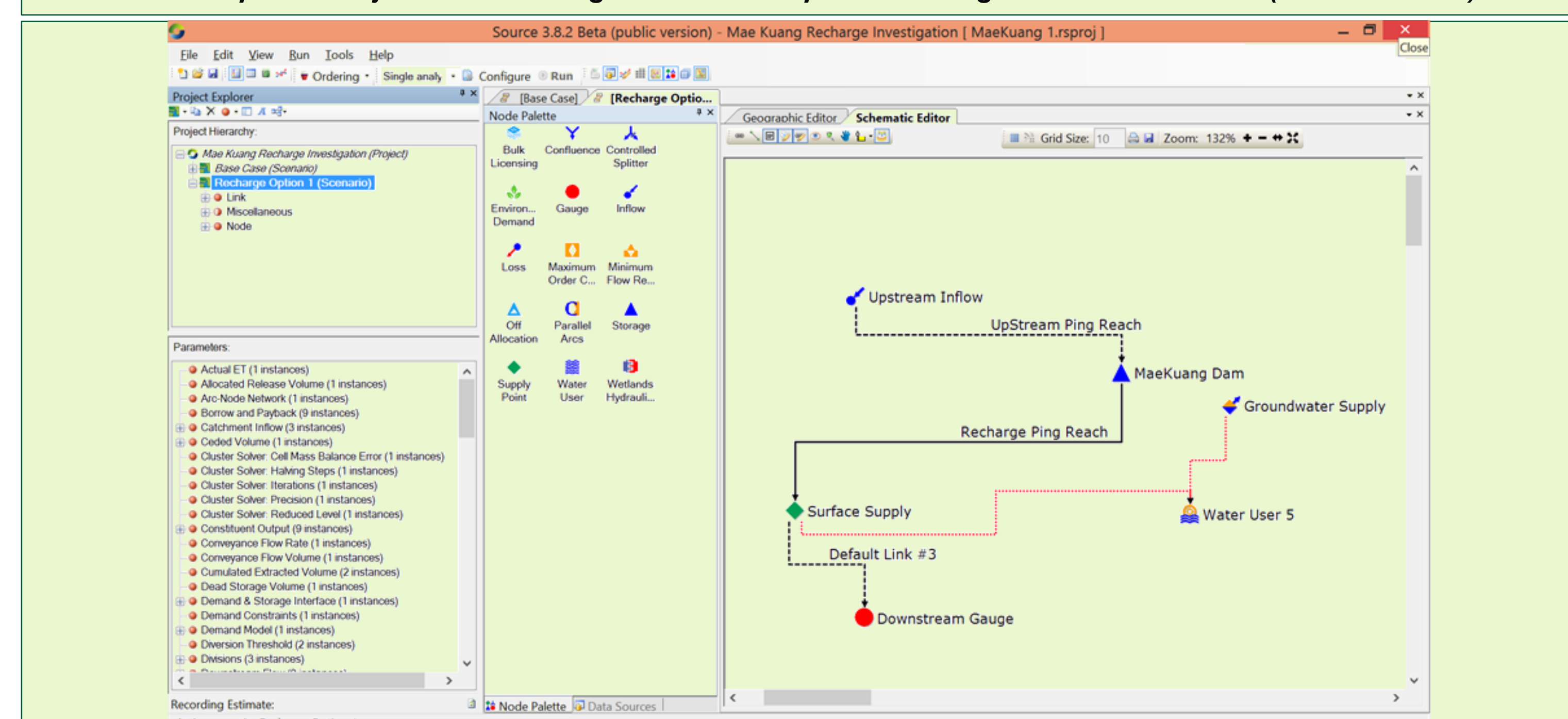
The great benefits of the conjunctive management are getting more and more attractive to Thai water managers. The reason for this is that even a single large reservoir is very difficult to build due to environmental concerns. Restoring water in subsurface reservoirs is possible, applicable, and useful.

The feasibility investigation of re-operation of reservoirs in conjunction with groundwater systems for flood mitigation and avoiding groundwater depletion should be carried out for the first time in Thailand. In addition, Thai water-related agencies regarding irrigation water, surface water, and groundwater should have a logical connection under one umbrella ministry-level organization. Both are substantial steps which must be taken to move towards sustainable conjunctive management.

Irrigated Area of Mae Kuang Dam with Wells and Groundwater Potential



An Example of Conjunctive Modeling with Dam Re-operation using eWater Source 3.8.2 (Public Version)



## References

- Bejranonda, W., Koontanakulvong, S., Koch, M. and Suthidhumajit, C., 2006. Groundwater modeling for conjunctive use patterns investigation in the Upper Central Plain of Thailand. In: Proceedings of Aquifers Systems Management, IAH and BRGM, May 30 – June 1, Dijon, France.
- Burley, N., Maher, K. and Lund, J., 2012. Re-operation of major reservoirs for flood and environmental management. In: Proceedings of World Environmental and Water Resources Congress, ASCE-EWRI, May 20 – 24, Albuquerque, New Mexico, USA.
- Jampanil, D., 2003. Water Allocation Planning under Conjunctive Use in the Chanasutr irrigation Project Area. Dissertation for the Master Degree. Bangkok: Chulalongkorn University (in Thai).
- Natural Heritage Institute (NHI), 2011. Feasibility Investigation of Re-Operation of Shasta and Oroville Reservoirs in Conjunction with Sacramento Valley Groundwater Systems to Augment Water Supply and Environmental Flows in the Sacramento and Feather Rivers, Northern Sacramento Valley Conjunctive Water Management Investigation. Natural Heritage Institute, San Francisco, California, USA.
- Pavelic, P., Srisuk, K., Saraphirom, P., Nadee, S., Pholkern, K., Chusanathas, S., Munyou, S., Tangsutthinnon, T. and Intarasut, T., 2012. Balancing-out floods and droughts: Opportunities to utilize floodwater harvesting and groundwater storage for agricultural development in Thailand. Journal of Hydrology, 470–471, 55–64.
- Philbrick, C. R. and Kitanidis, P. K., 1998. Optimal conjunctive-use operations and plans, Water Resources Research, 34(5), 1307–1316.
- Public Policy Institute of California, 2011. Managing California's Water From Conflict to Reconciliation. Public Policy Institute of California, San Francisco, California, USA.
- Tanaka, S. K., Zhu, T., Lund, J. R., Howitt, R. E., Jenkins, M. W., Pulido, M. A., Tauber, M., Ritzema, R. S. and Ferreira, I. C., 2006. Climate Warming and Water Management Adaptation for California. Climate Change, 76(3–4), 361–387.
- USACE, 2002. Conjunctive Use for Flood Protection. US Army Corps of Engineers (USACE), Institute for Water Resources, Hydrologic Engineering Center, California, USA.