ECONOMICS OF GROUNDWATER MANAGEMENT WITH ENVIRONMENTAL CONCERNS:
CASES OF COASTAL AQUIFER

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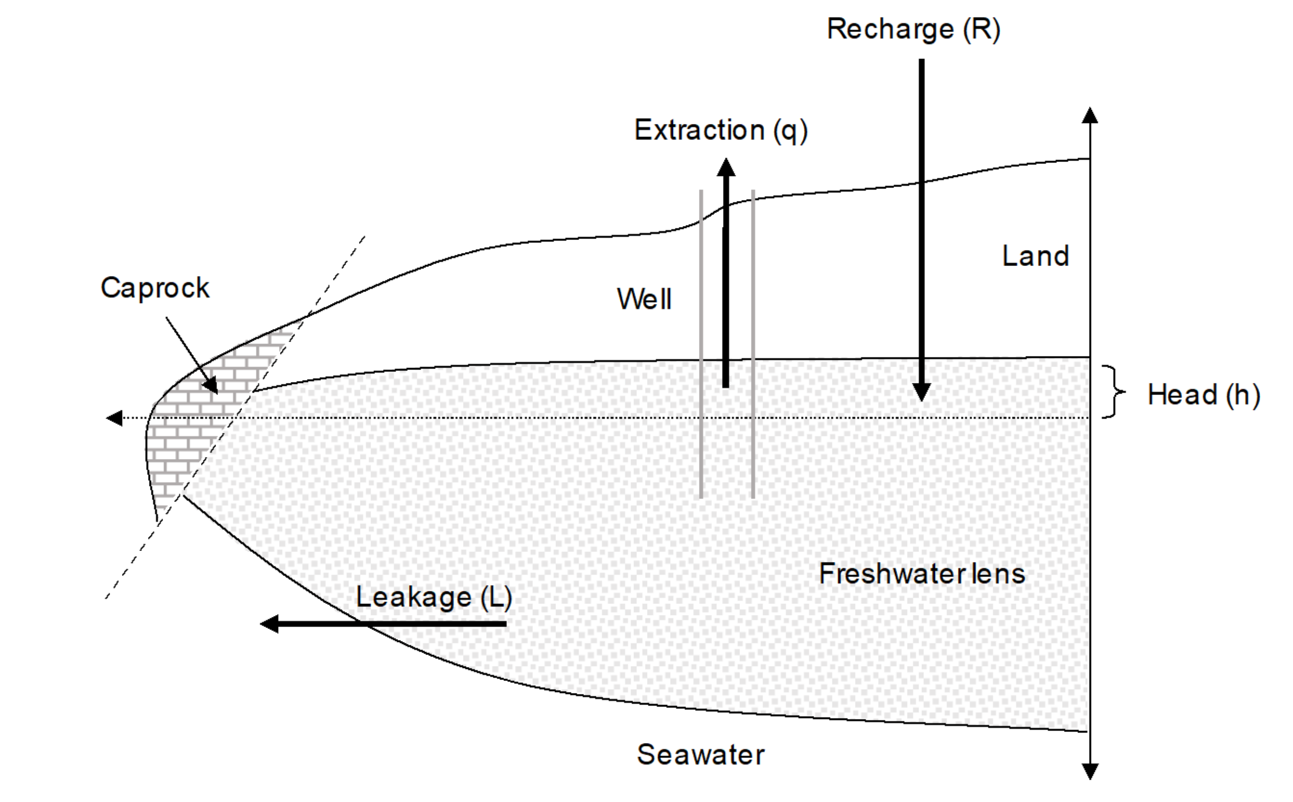
SUMMARY OF THE PRESENTATION

- Economics of groundwater management. Coastal aquifer as a renewable resource
- Sustainable yield is incomplete as a management strategy
- Optimal extraction is sustainable, but not the other way around
- Groundwater management with environmental concerns
  - Downstream dependent ecosystem (via SGD)
  - Upstream watershed management (via recharge or uptake)
- Other possible extensions

CROSS-SECTION OF COASTAL AQUIFER



Roumasset and Wada (2012)

MANAGEMENT STRATEGY

- Safe yield --- equal to recharge
- Sustainable yield – equal to net recharge (incl. discharge)
- Sustainable groundwater management accounting for hydrological, environmental and socioeconomic consequences of pumping, while incorporating stakeholder participation and adaptive governance (Elshall et.al., 2020)
- What is the approach path that maximizes the contribution of an aquifer to the general welfare?

ECONOMICS OF GROUNDWATER

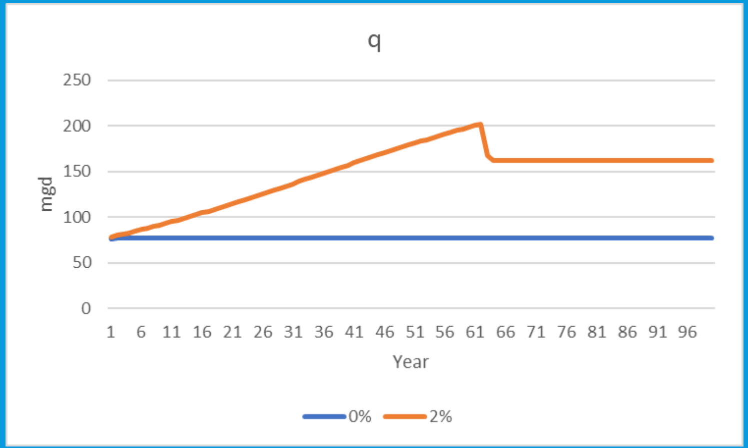
$$max_{q_t,b_t} \int_0^{\infty} e^{-rt}\left[B(q_t + b_t) - c_q(h_t)q_t - c_b b_t\right] dt$$

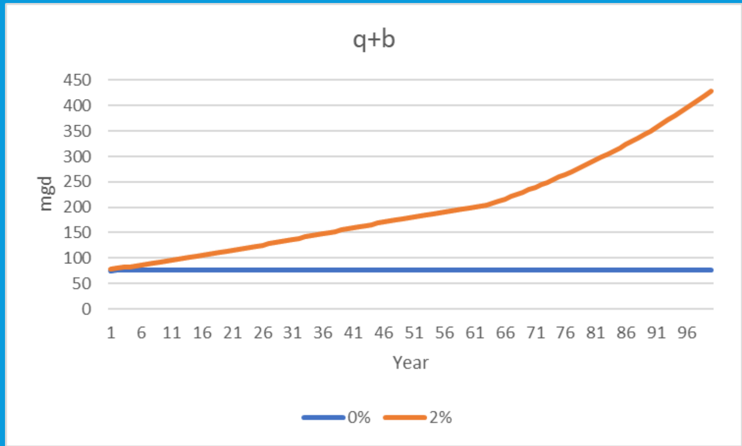
$$\gamma \cdot \dot{h} = R - L(h_t) - q_t$$

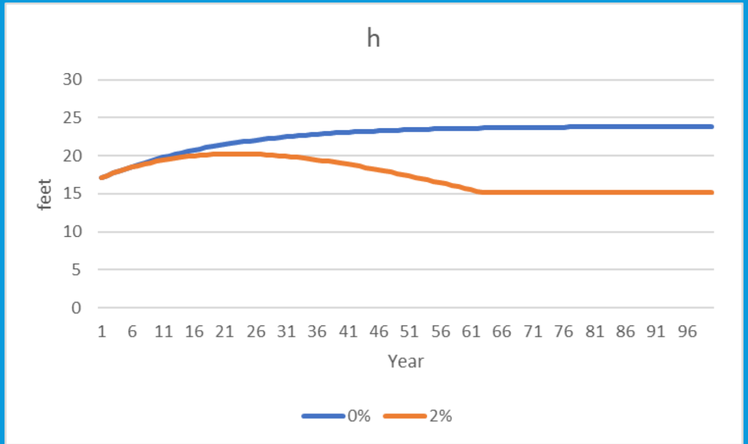
F.O.C $\quad p_t = c_q(h_t) + \frac{\dot{p}}{r}$

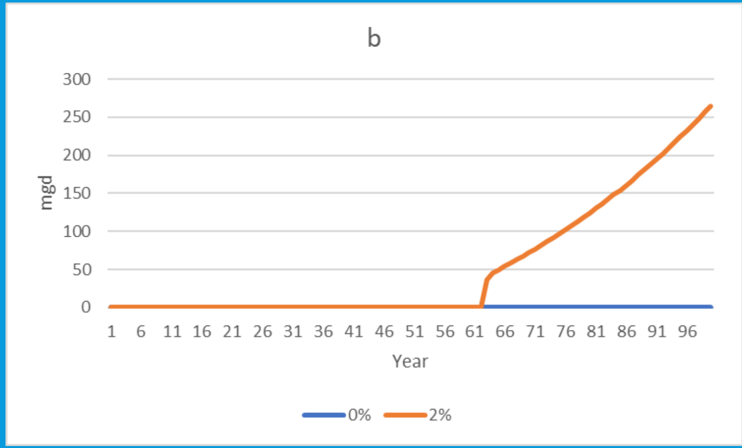
$$p_t - c_q(_{h_t}) = \frac{\dot{p}}{r} + \frac{\left[p_t - c_q(_{h_t})\right]F'(h_t)}{r} - \frac{c_q'(_{h_t})F(h_t)}{r}$$

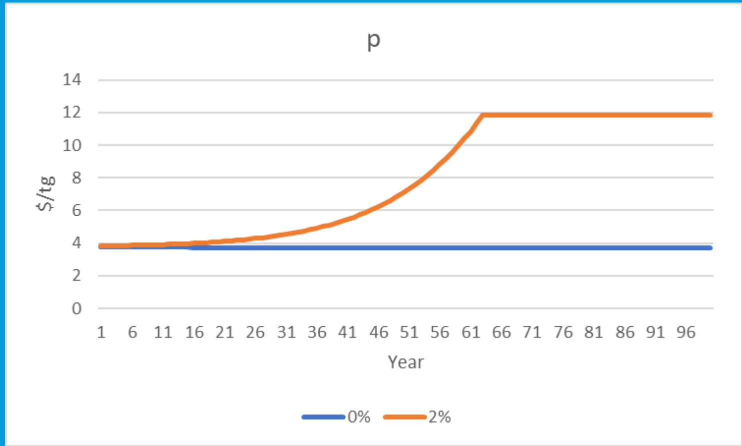
THE PEARL HABOR AQUIFER, HAWAII



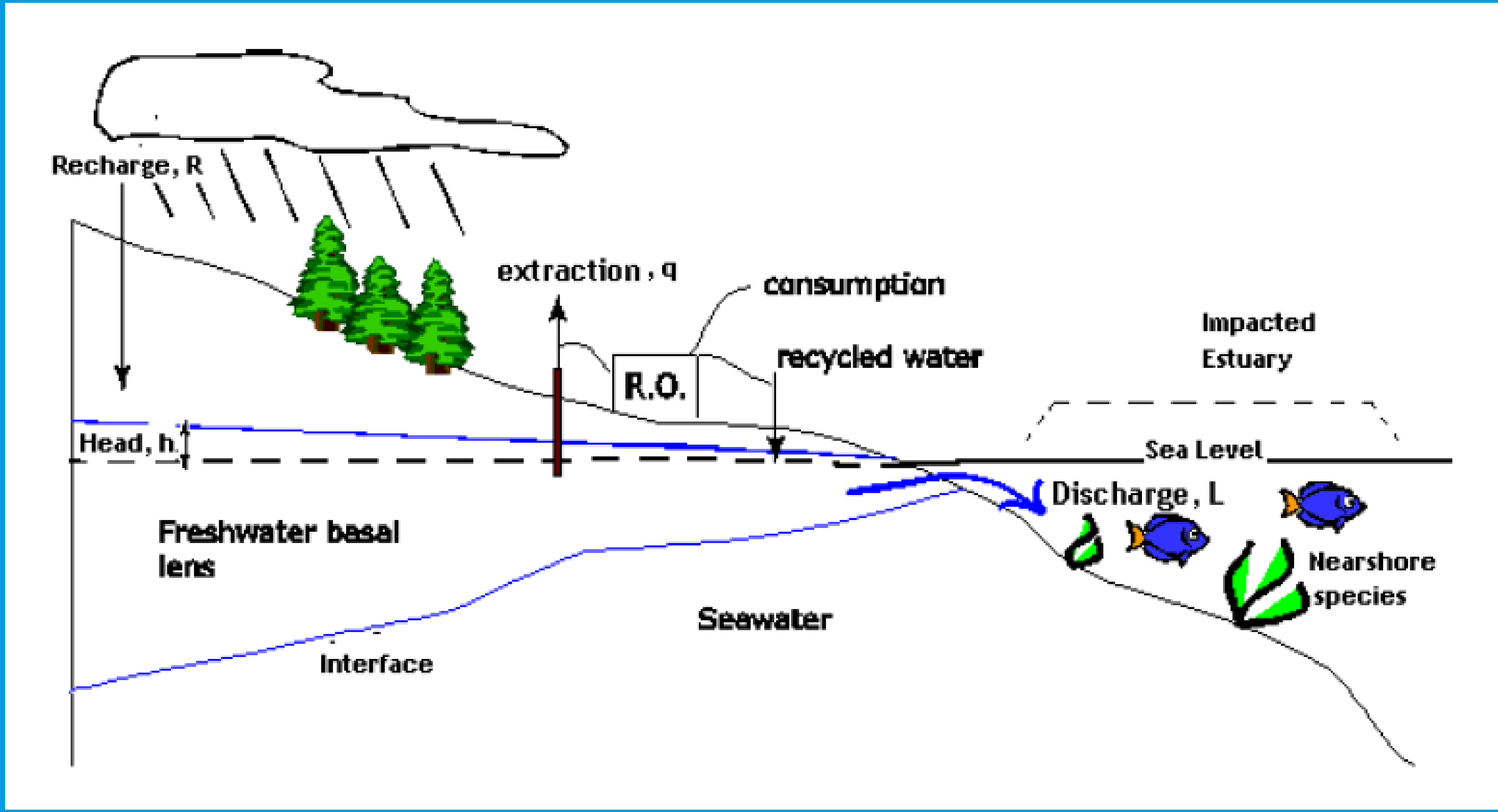






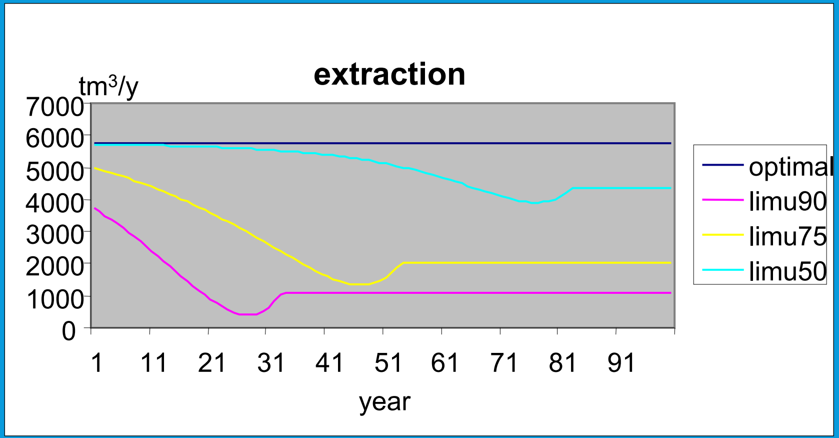


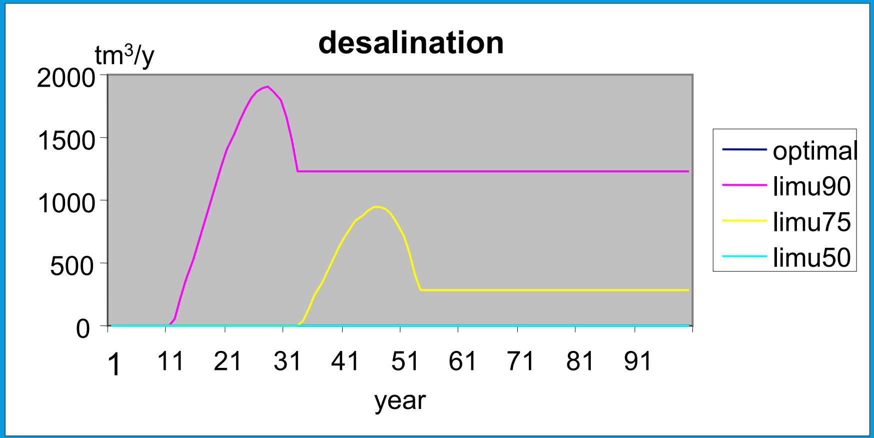
DEPENDENT ECOSYSTEM (DOWNSTREAM)

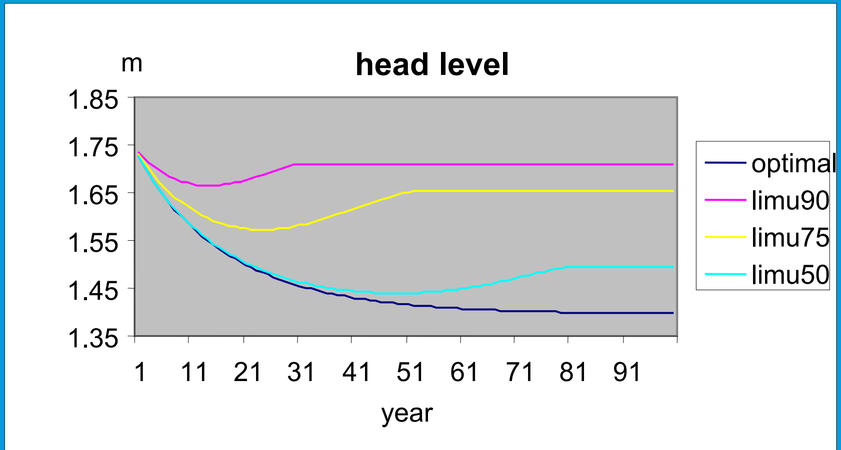


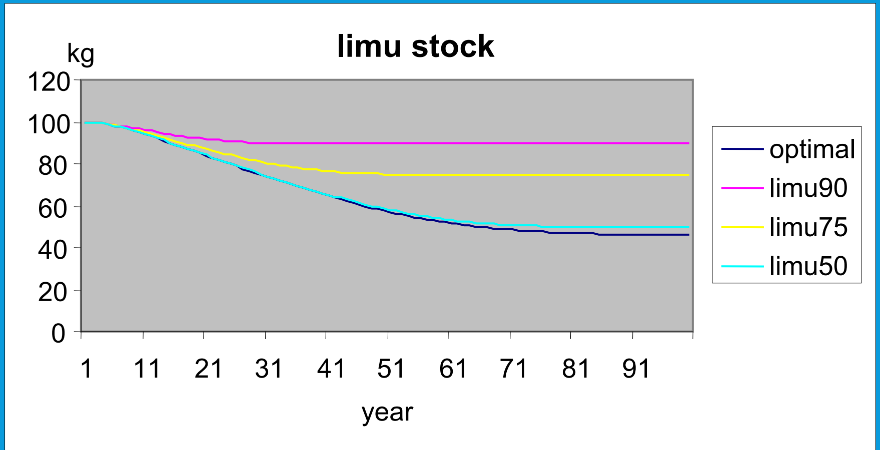
Pongkijvorasin et.al. (2010)

TAKING INTO ACCOUNT “LIMU”

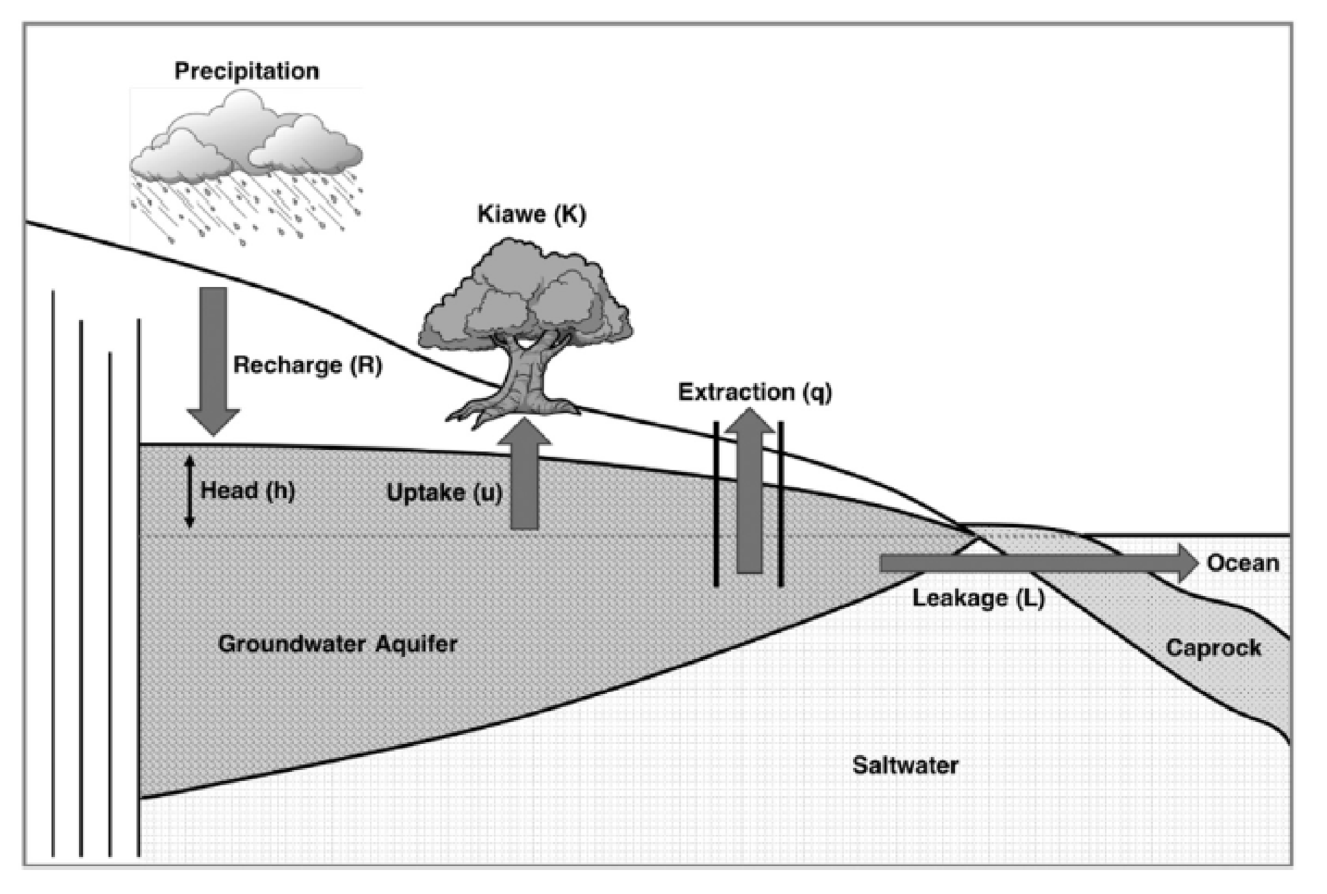






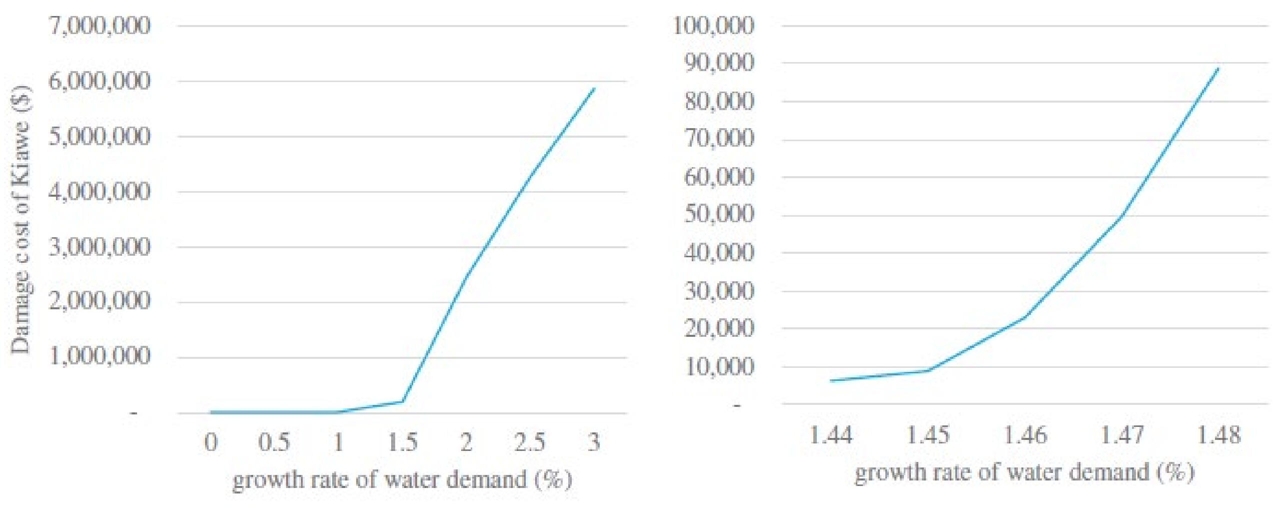


INVASIVE REMOVAL



Pongkijvorasin et.al. (2018)

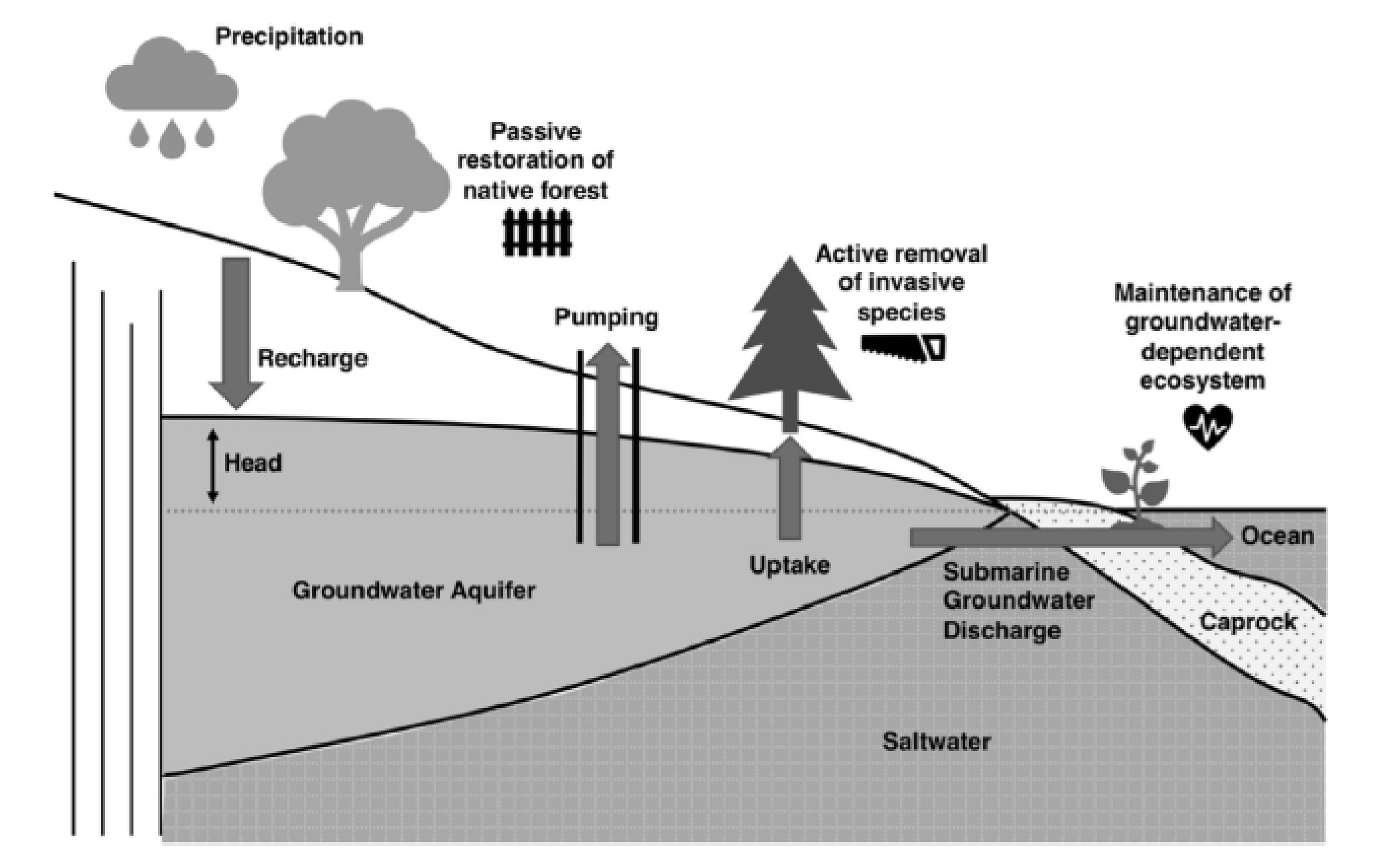
TO REMOVE OR NOT?



(a) Growth rate of water demand 0-3% (b) Growth rate of water demand 1.44-1.48%

- Damage costs of the invasive depend on growth rate of water demand. So the decision to remove it or not also depends on the growth rate of water demand as well.

WATERSHED PROTECTION

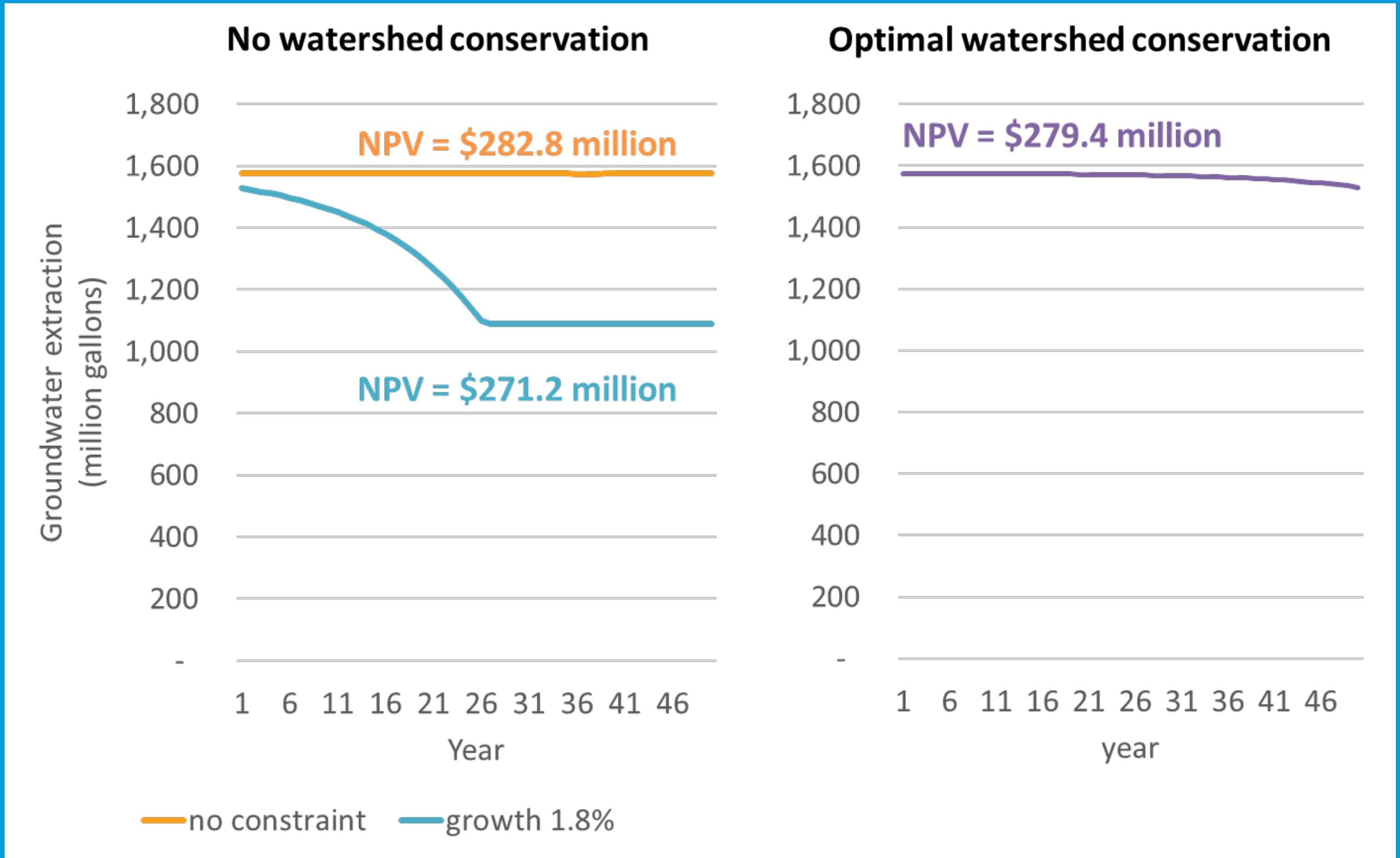


Pongkijvorasin et.al. (2020)

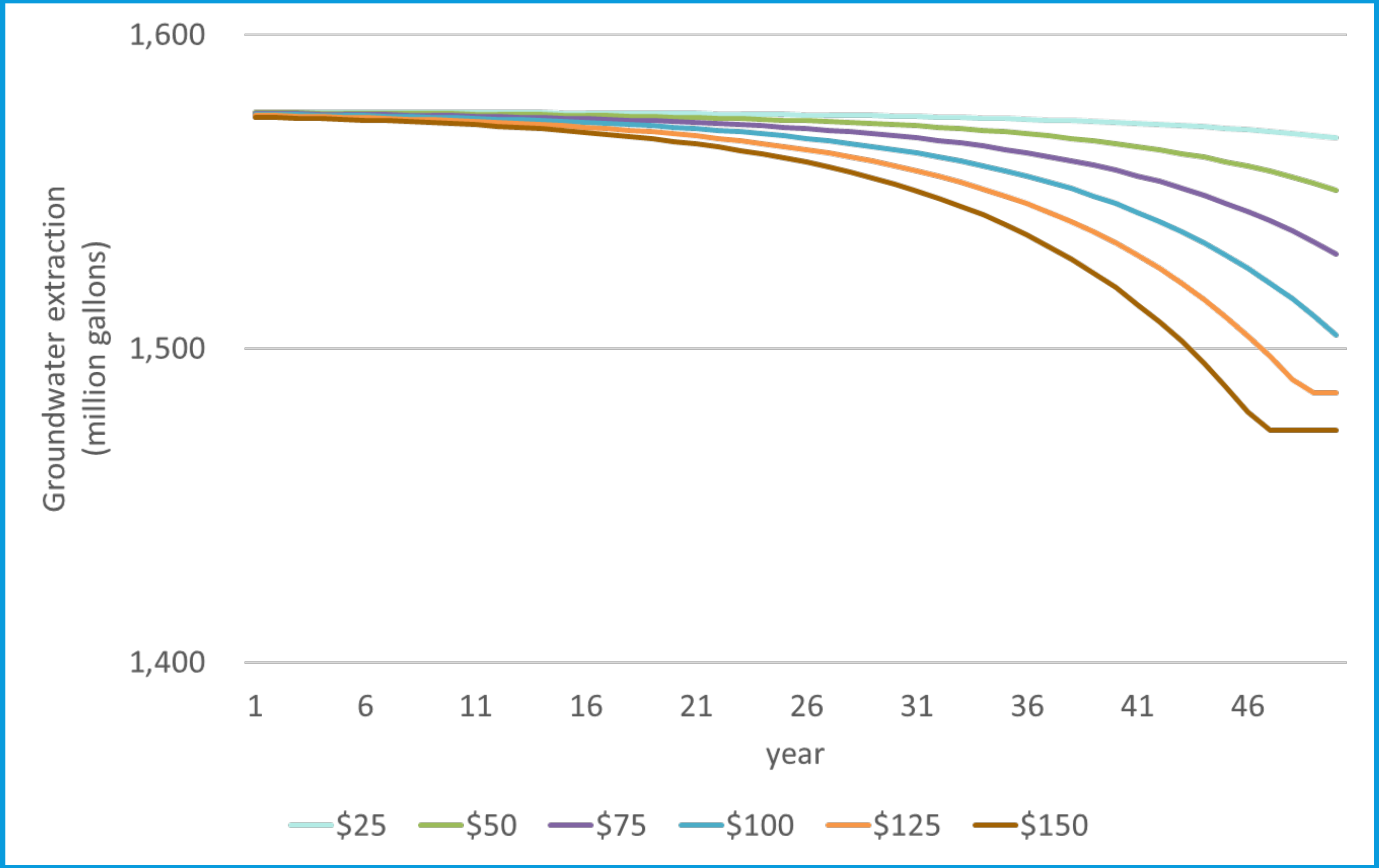
OPTIMAL FENCE SIZE (1.8% GROWTH CONSTRAINT)

Per-unit cost ($/ft/50-yr)	First-year installation size (acres)	NPV over 50 years (million $)
25	3,135	281.62
50	2,984	280.51
75	2,869	279.42
100	2,761	278.37
125	2,661	277.34
150	2,567	276.33
288	2,100	271.19
≥289	0	271.21
Benchmark no fence	0	271.21

FENCING PARTIALLY OFFSETS LOSS FROM ECOSYSTEM PROTECTION



OPTIMAL EXTRACTION



OTHER EXAMPLES

- Impacts of climate change on groundwater aquifer --- e.g. , decline in recharge
- Multi-instrument management of watershed conservation
- Multi-aquifer management
- Thai’s context
  - Land-subside
  - Salinity
  - Recharge improvement (seepage from canal or irrigation system)

THANK YOU

Comments and suggestions are welcome.

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