Inflow calculation for on-farm ponds in northeast Thailand

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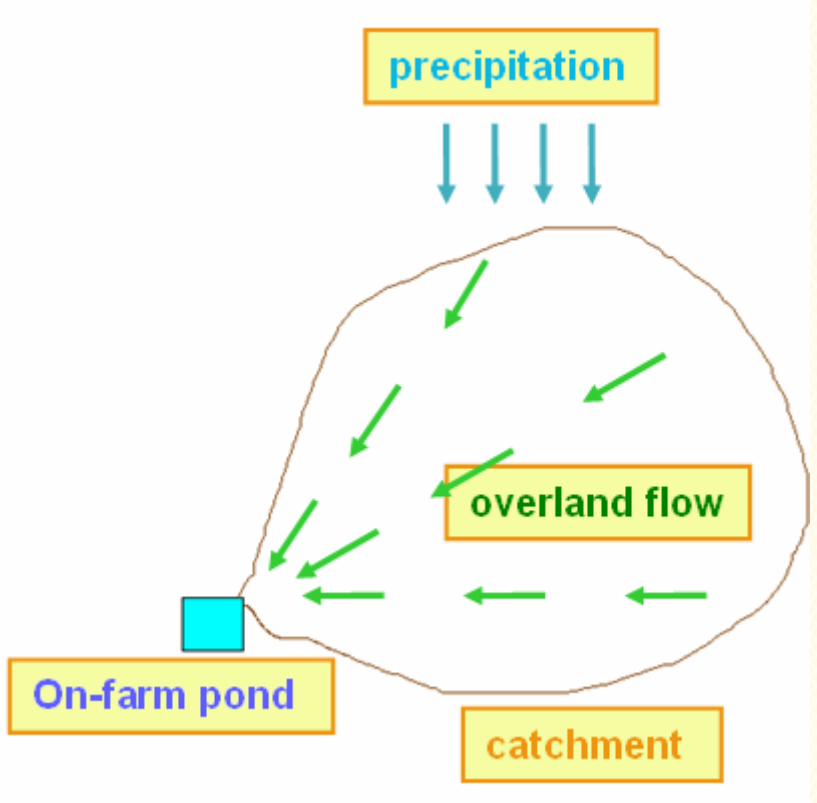


Northeast, Thailand

- More than 85 % of agricultural land is rainfed agriculture
- Erroneous rainfall pattern
- Unfertile soil-sandy texture
- Poor farmers.

On-farm pond

- the most suitable technology for water harvesting
- collecting rain water in rain season and use in dry season
- easily construction
- environmentally sound
- economically sufficient

Benefit from on-farm is several. Such as upland crops and horticulture

Irrigation supplementary

Fisheries

Number of on-farm ponds in northeast is tremendous

- increasing rapidly
- only one third are fully utilized
- the rest are inefficient or even useless

Number of on-farm ponds is tremendous

Amount of inflow is very critical for usability and sustainability

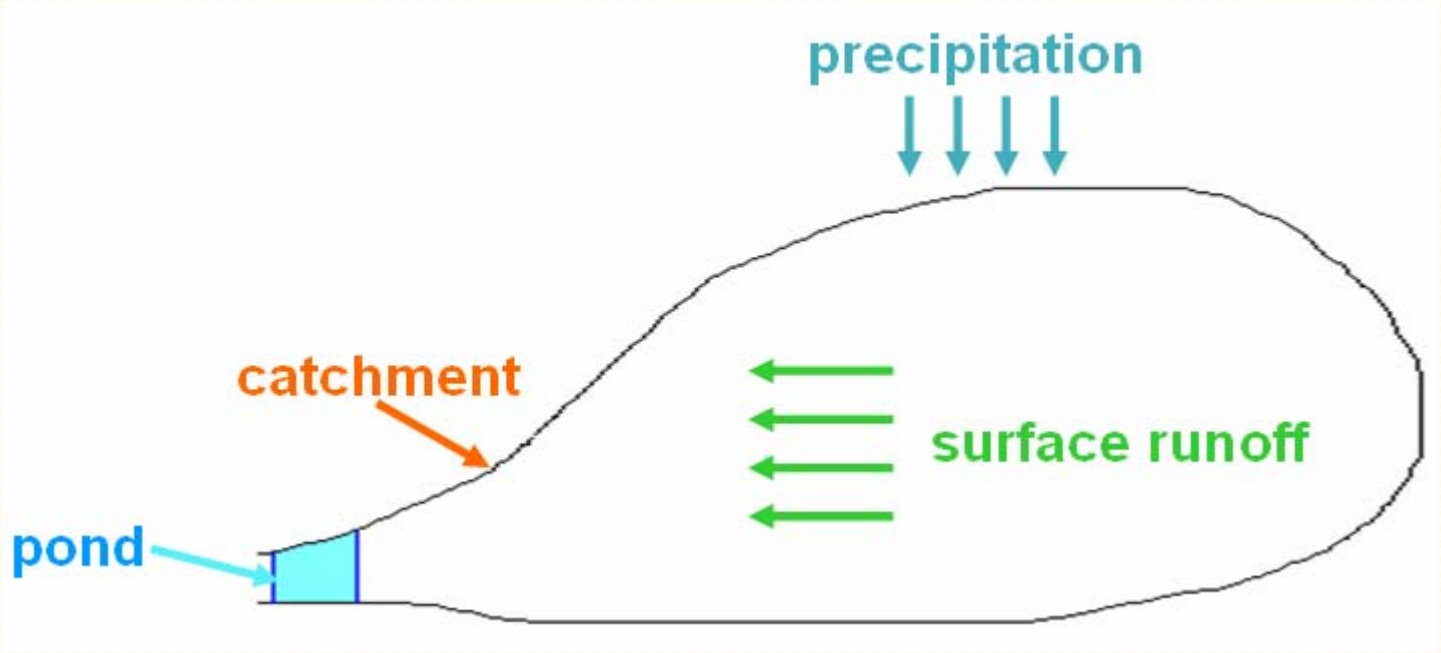
- too much inflow
  - can damage the pond by erosion
  - increase silting and sediment deposition
- too small inflow
  - not enough water for utilization

Not enough inflow makes the pond useless

Too much inflow damage the pond

Our objective is to study inflow to on-farm pond

- Inflow into a pond is a function of
  - precipitation
  - catchment characteristics



Two types of on-farm ponds

- **Dammed pond**

  To build a dam across a valley

  - **cheaper, easier to manage**
  - **difficult to find suitable place**

- **Dug-out pond**

  To dig a pit, add embankment, and equipped with inlet and/or outlet facilities.

  - **suitable for flat area**
  - **more popular in the Northeast**

Hydrologic concepts

On-farm ponds fill up during rainy season from

- **rainfall**
- **catchment runoff**
- **groundwater inflow**

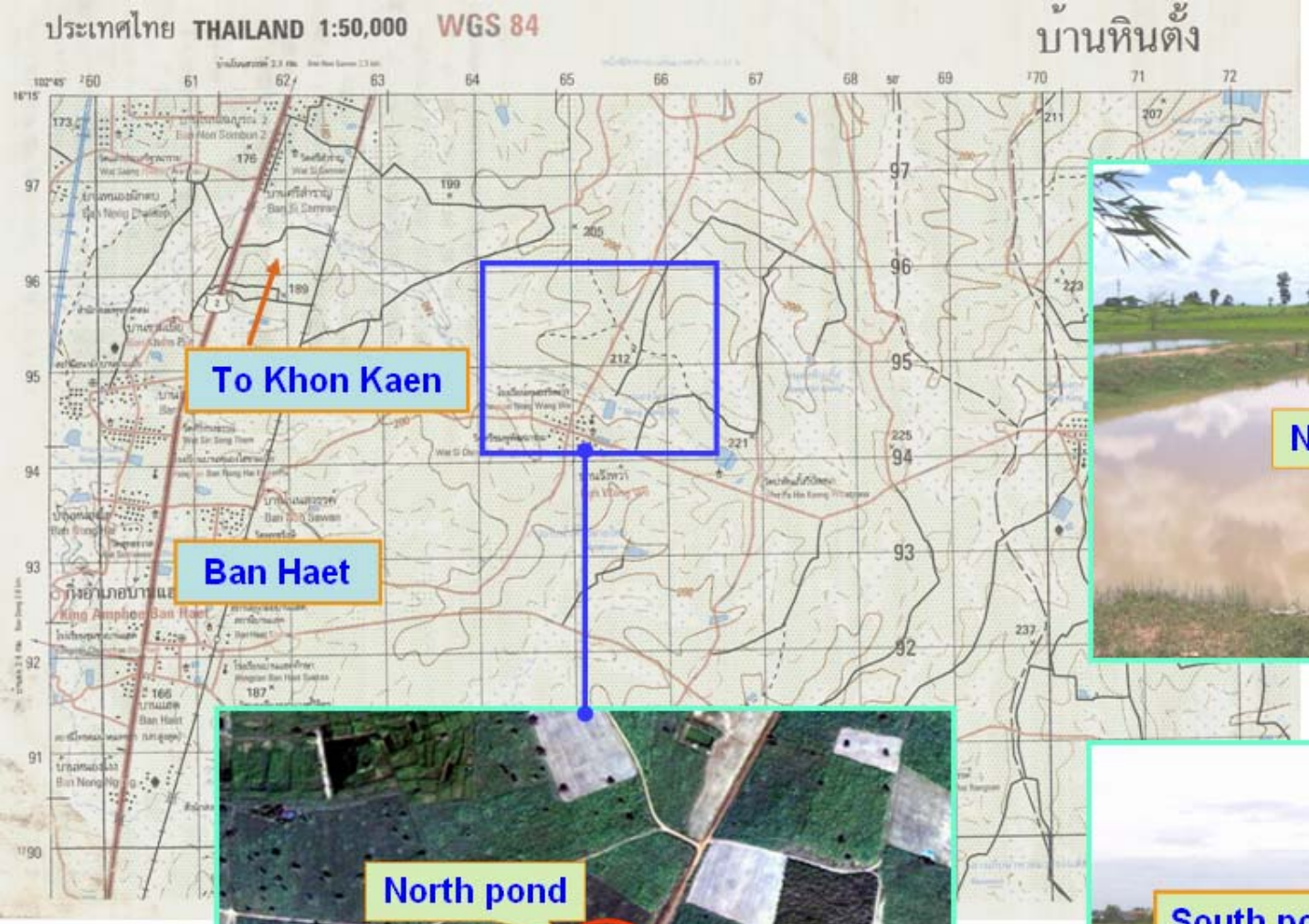
The ponds lose water during dry season through

- **water usage**
- **evaporation**
- **seepage loss**

Site selection

- **Two on-farm ponds were selected near Ban Wang Wa about 20 km south of Khon Kaen city.**

- **The two ponds are near by each other**
  - **the North pond and the South pond**
    - **~ dimensions: 20 x 30 x 4, 17x 33x 4 m^3**
    - **~ elevations of the bottoms 194.4 m, 195.0 m**


ประเทศไทย THAILAND 1:50,000 WGS 84
บ้านหินตั้ง
To Khon Kaen
Ban Haet


North pond
South pond

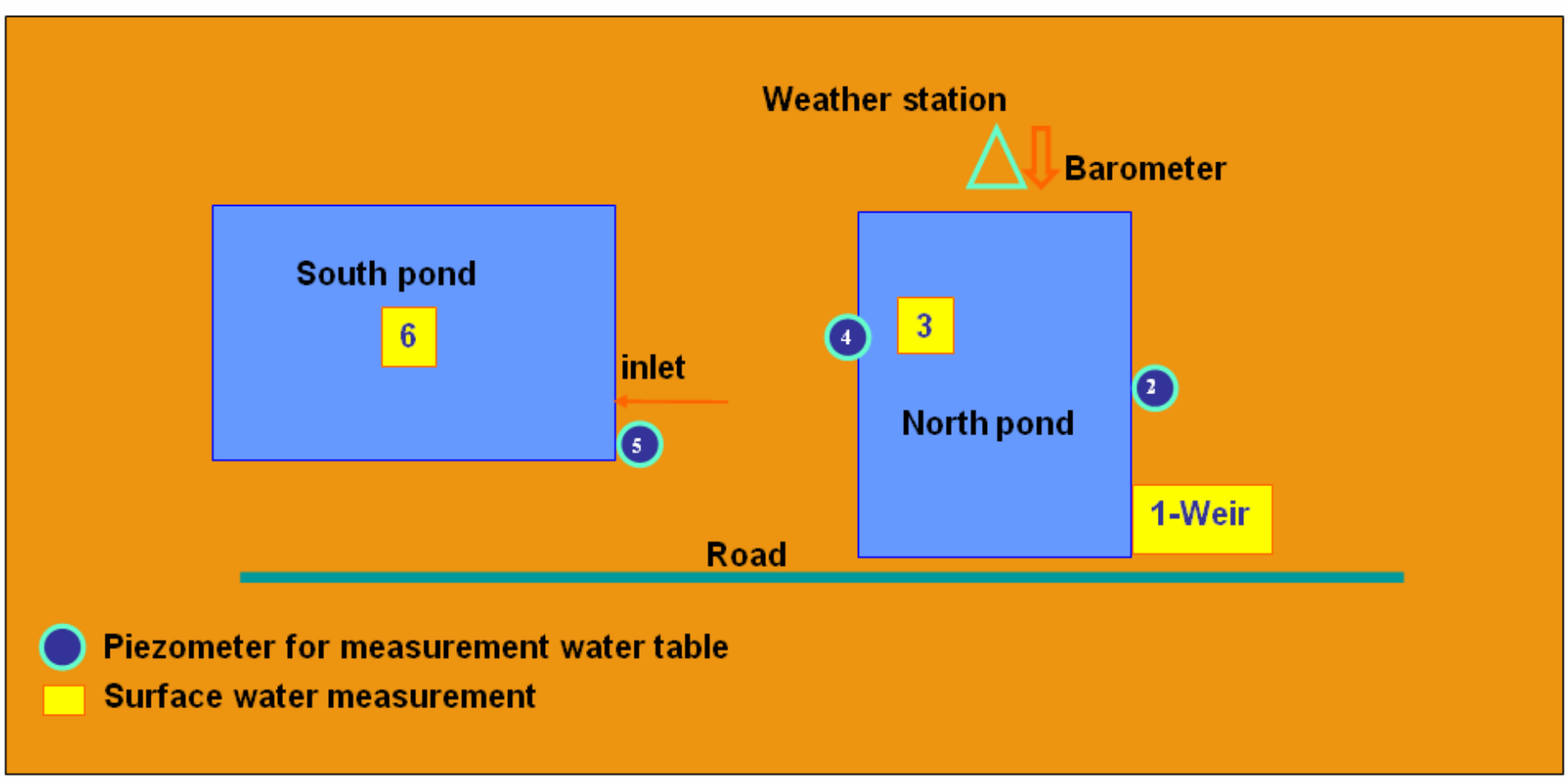

North pond


South pond

Equipments installation

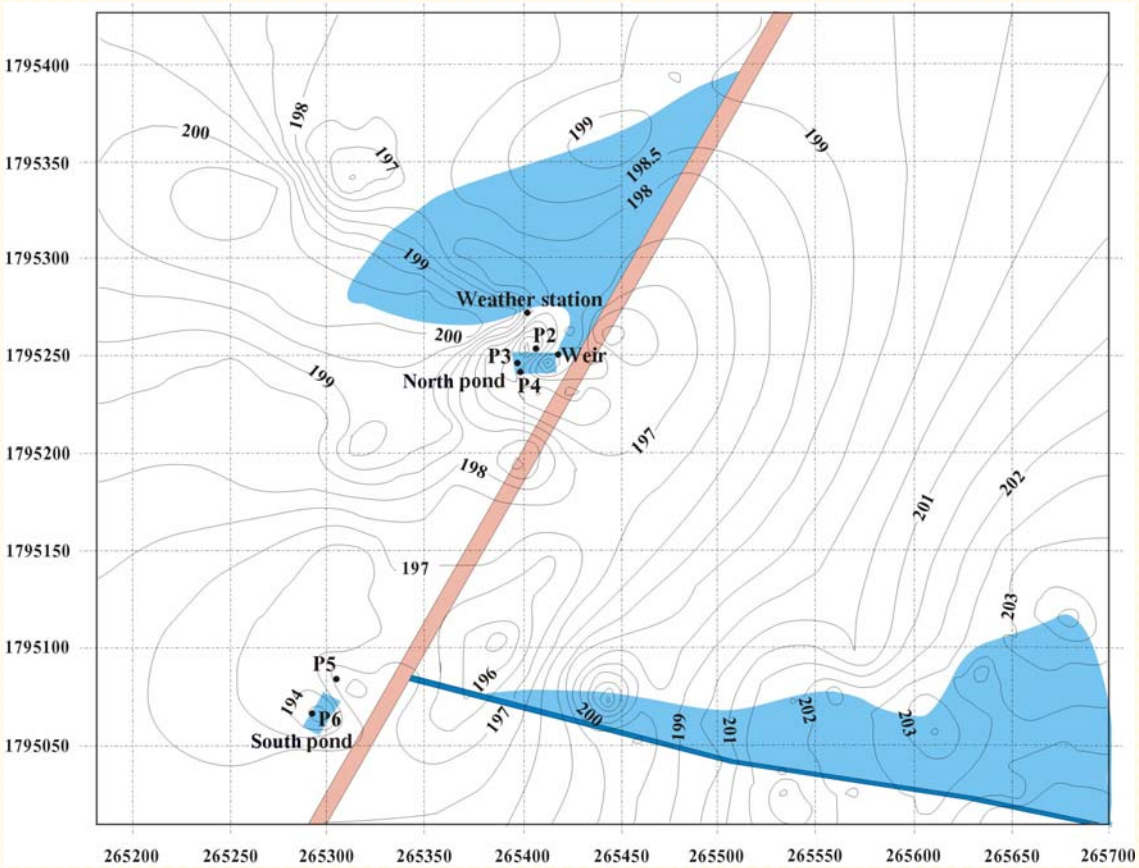
- **Weather station**
- **Piezometers with water table recorders**
- **Pond water level recorders**
- **V-notch weir with a water level recorder for inflow measurement**

Plan view of the equipments



Set up equipments

Catchment areas of the two ponds



- North pond: 10643 m^2, 6.7 rai, butterfly shape
- South pond: 12618 m^2, 7.9 rai, elongated shape

To compare two methods of inflow calculation

- **Watershed routing**

  ~ **using the concept of outflow from a catchment varies nonlinearly with storage**

- **Synthetic unit hydrograph**

  ~ **Unit hydrograph is direct runoff hydrograph causing by 1 cm of rainfall of specific duration**

  ~ **Synthetic unit hydrograph to be constructed from catchment characteristics**

Watershed routing technique

Assuming that outflow varies linearly with storage

$$s = kq$$

At two time steps t_1 and t_2, we obtain

$$q_2 = \frac{k - 0.5\Delta t}{k + 0.5\Delta t} q_1 + \frac{\Delta t}{k + 0.5\Delta t} i$$

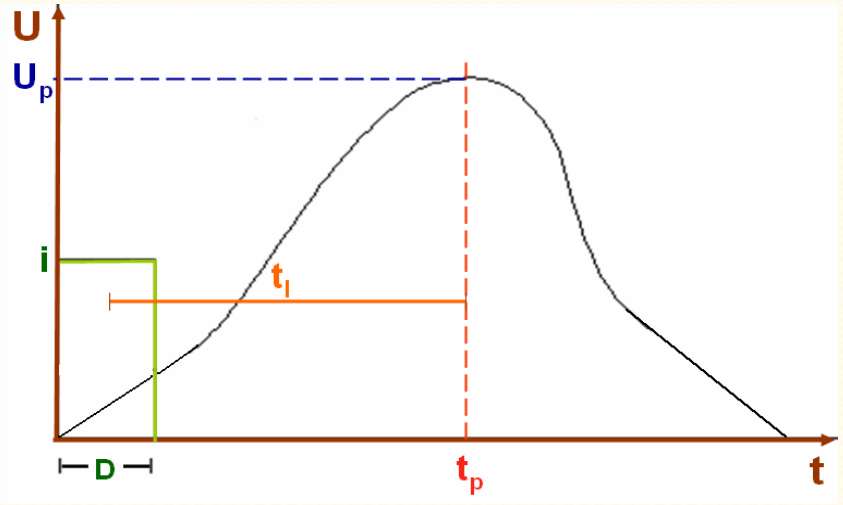
That is by knowing q_1, Δt, and i

then q_2 can be estimated.

Synthetic unit hydrograph for small watershed

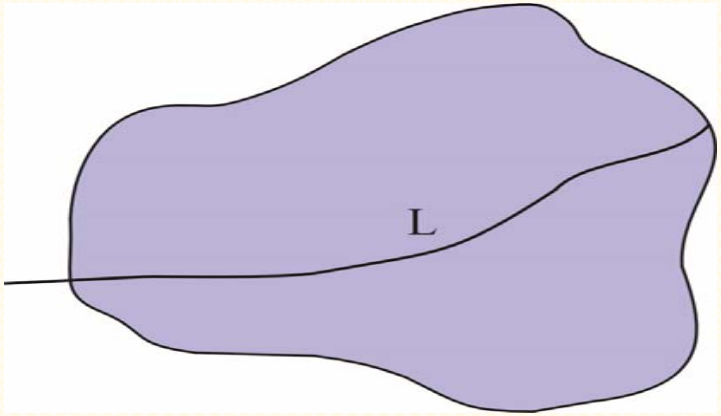
- Time of concentration $t_c = 0.0195 C_k (L / S^{0.5})^{0.77}$

- Lag time $t_l = 0.6 t_c$



- Time to peak $t_p = t_l + \frac{D}{2}$

- Peak discharge $u_p = \frac{C_p A}{t_p}$



Assuming unit hydrograph shape follows

Probability distribution function of gamma function

as

$$u = u_p[(t/t_p)\exp(1-(t/t_p))]^{n-1}$$

where $n = f(C_p)$

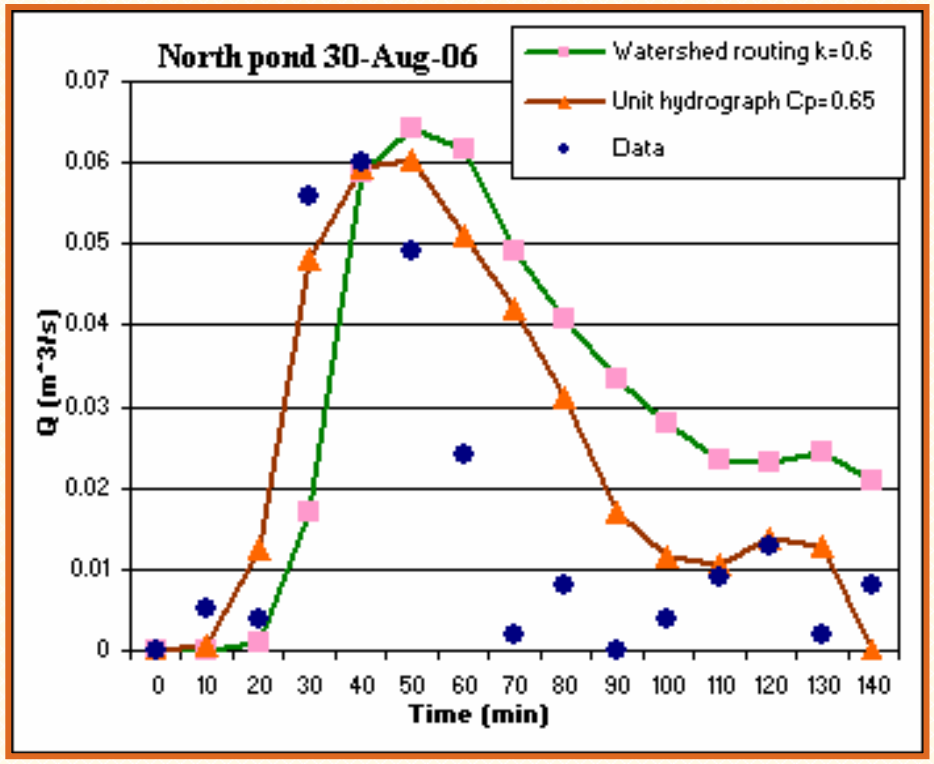
From unit hydrograph and rainfall we obtain inflow hydrograph

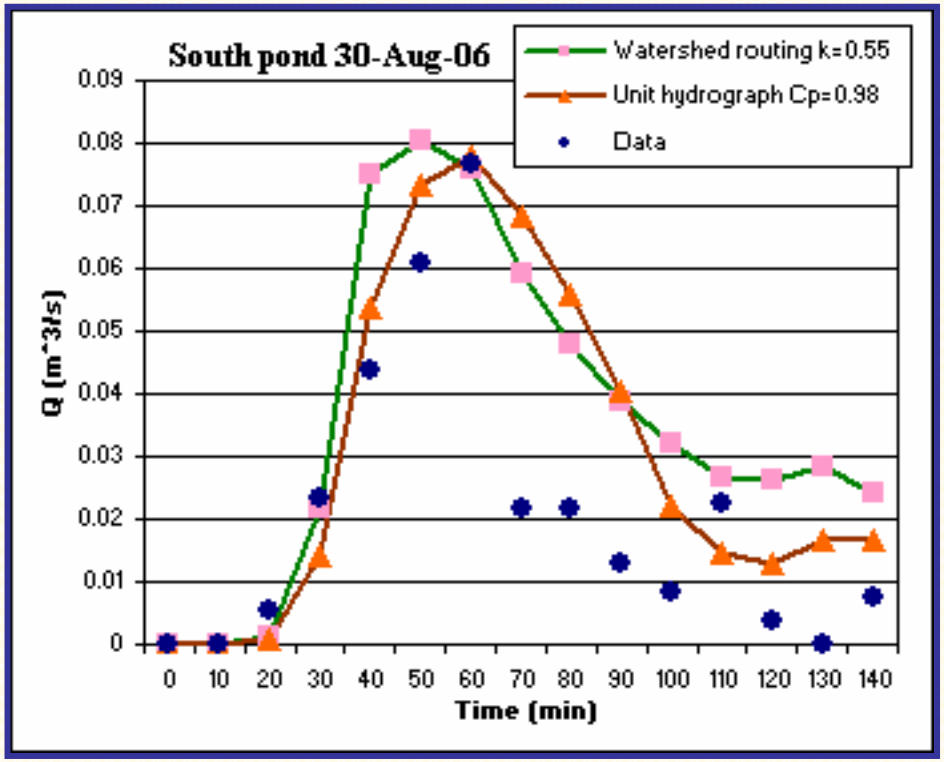
We compare the two techniques

- **watershed routing**
- **synthetic unit hydrograph**

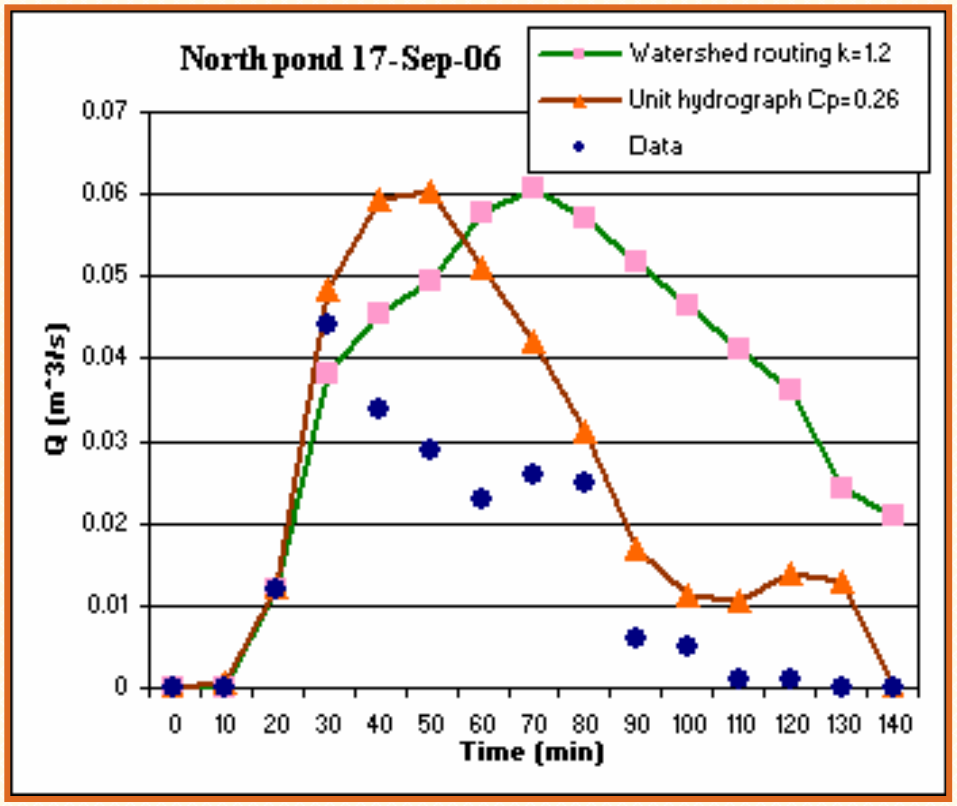
to the data of rainfall and inflow into the two on-farm ponds for the events of 30 Aug 06, 17 Sep 06, and 19 Sep 06

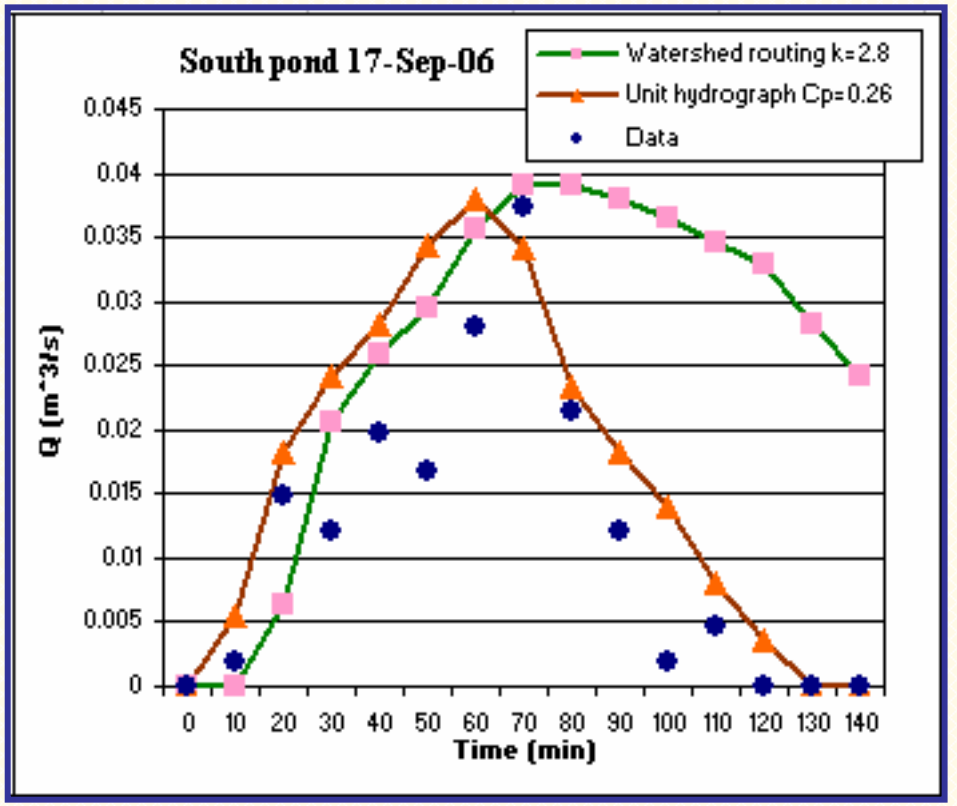
Comparison results for 30 Aug 06



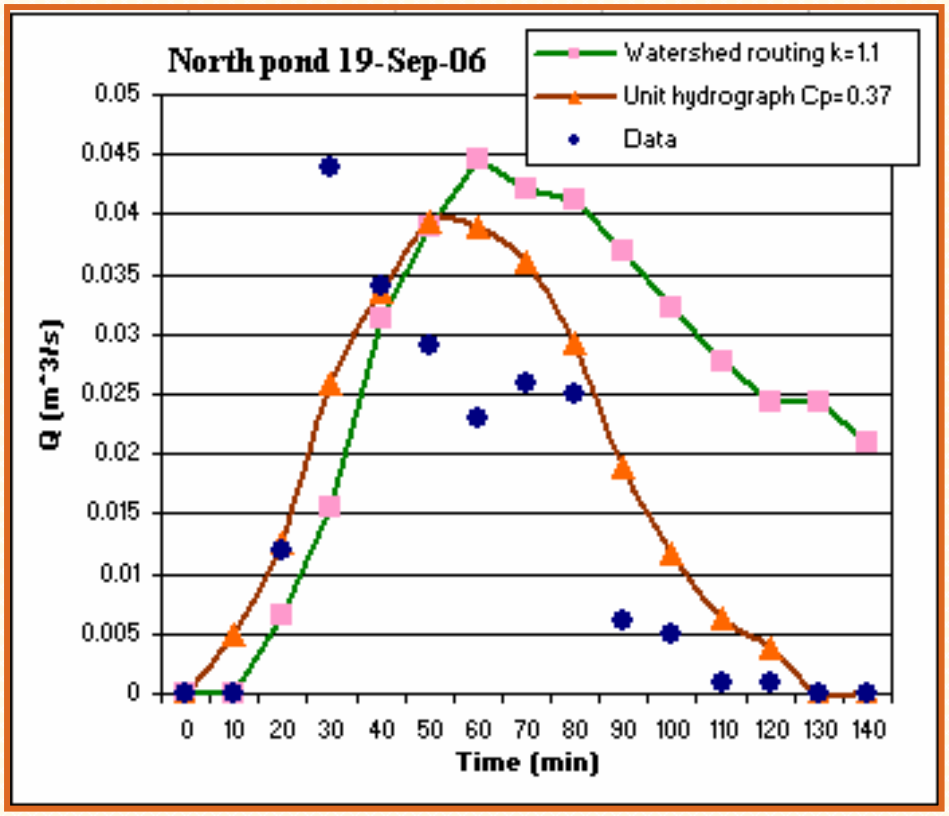


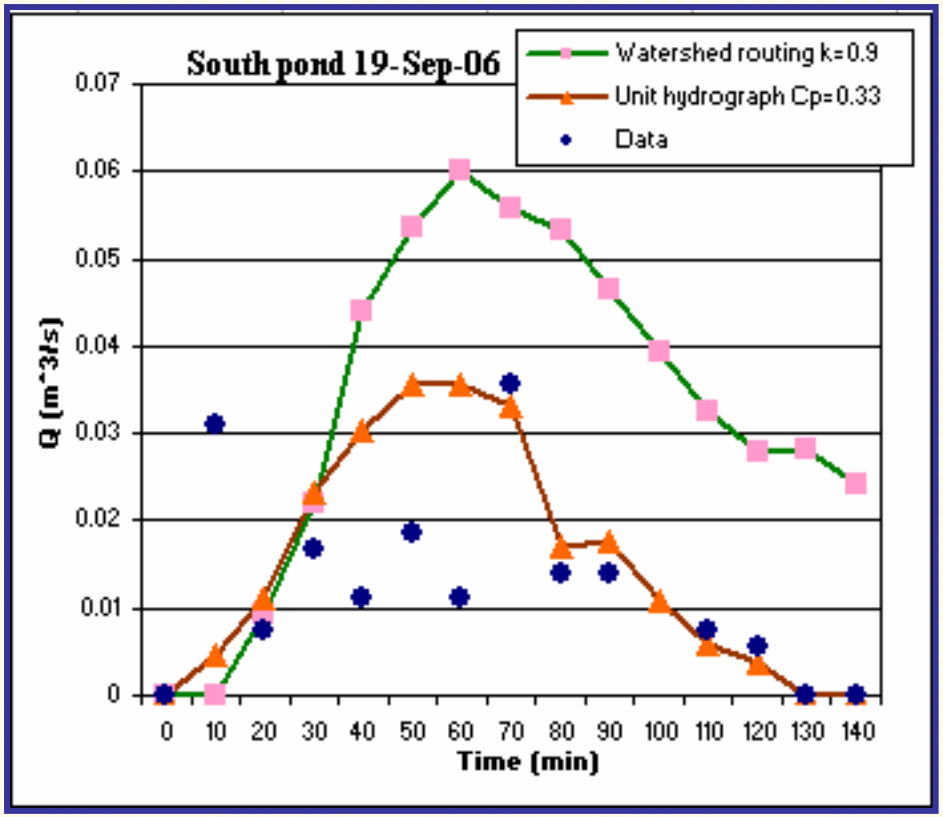
Comparison results for 17 Sep 06





Comparison results for 19 Sep 06





Suitable values of k for watershed routing and C_p for unit hydrograph

Rainfall event	North pond		South pond	
	k	C_p	k	C_p
30 August 2006	0.6	0.65	0.55	0.98
17 September 2006	1.2	0.26	2.8	0.26
19 September 2006	1.1	0.37	0.9	0.33

Variations in k and Cp show nonlinearity in the rainfall-runoff systems

Conclusions

- **Variation in Cp is less than in k**

- **Unit hydrograph technique gives better agreement with the data than watershed routing technique in peak discharge and runoff volume**

- **Appropriate value for Cp is 0.4 - 0.6 for Khon Kean area**