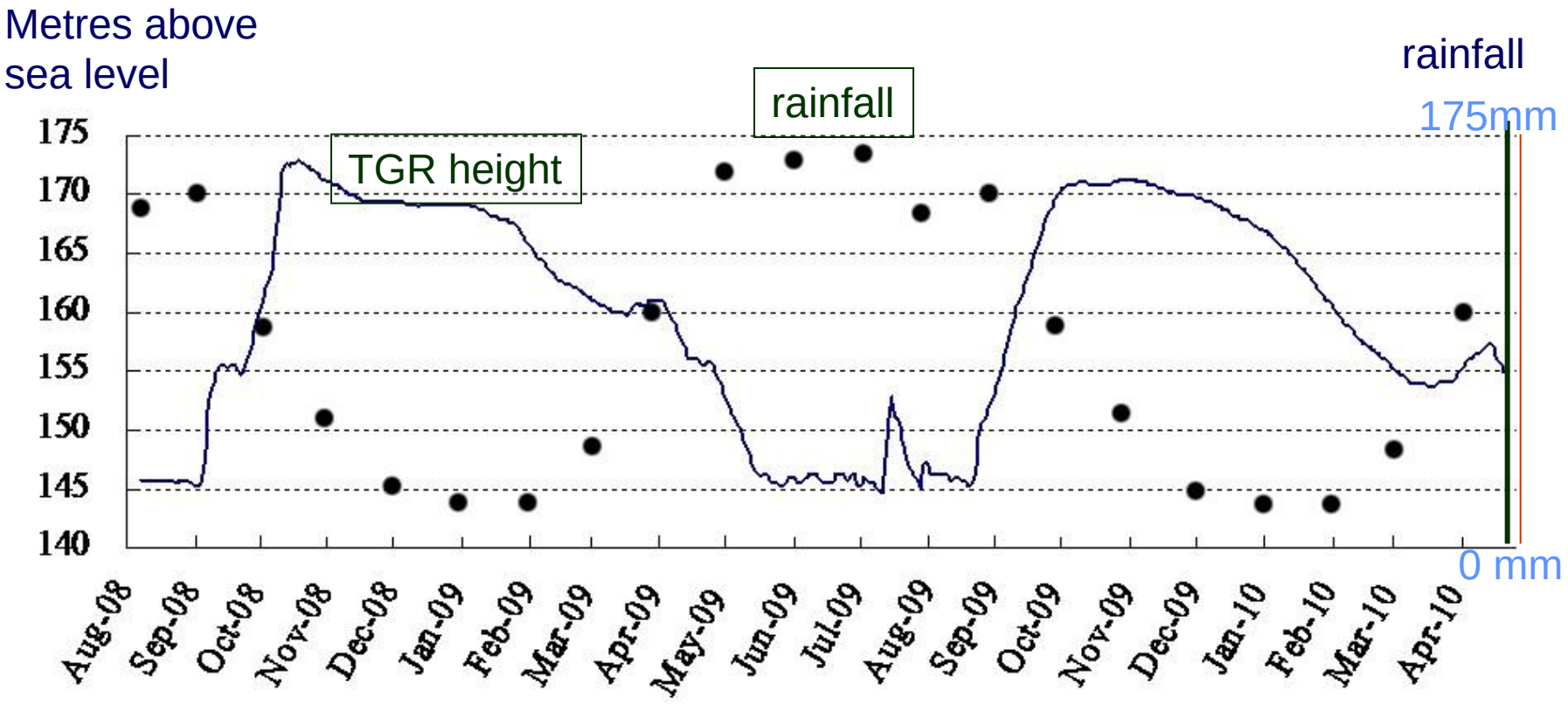
Eco-economic aspects of a dike-pond project in the drawdown zone of the Three Gorges Reservoir

Bo Li, XingZhong Yuan, and J.H. Martin Willison

College of Resources and Environmental Science, Chongqing University, Chongqing, China
Key Laboratory of Exploitation of Southwest Resources and Environmental Hazards Control Engineering, Ministry of Education, Chongqing University, Chongqing, China
School for Resource and Environmental Studies, Dalhousie University, Halifax, NS, Canada

Three Gorges Reservoir Management

- The Three Gorges Reservoir (TGR) is managed so as to store clear water in winter and dispatch sediment-laden water in summer
- The total drawdown zone area of TGR has been estimated to be about 35,000 ha (Zhang, 2008)

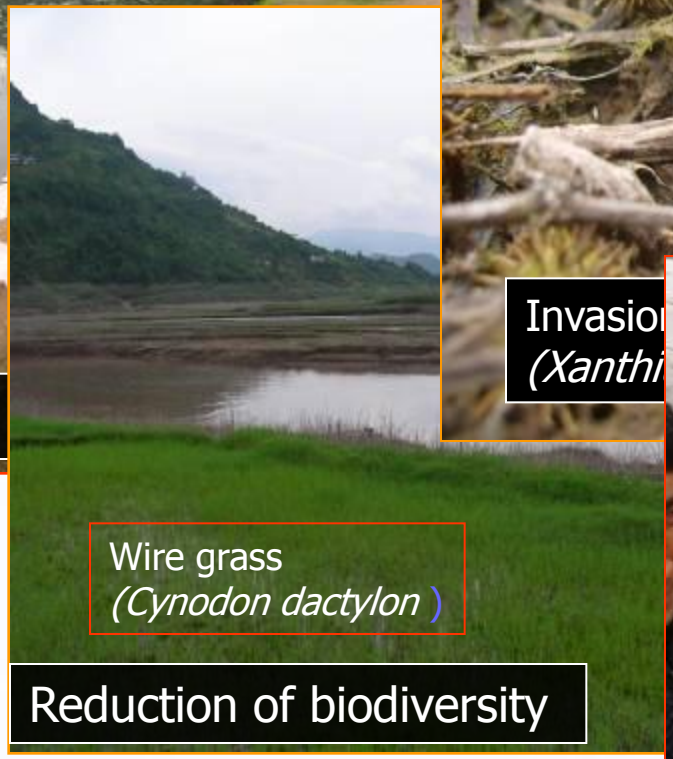


Water level (line) and mean rainfall (dots) in the Three Gorges Reservoir, August 2008 to April 2010

TGR data courtesy of Prof. Yuan

Some examples of problems

Soil erosion

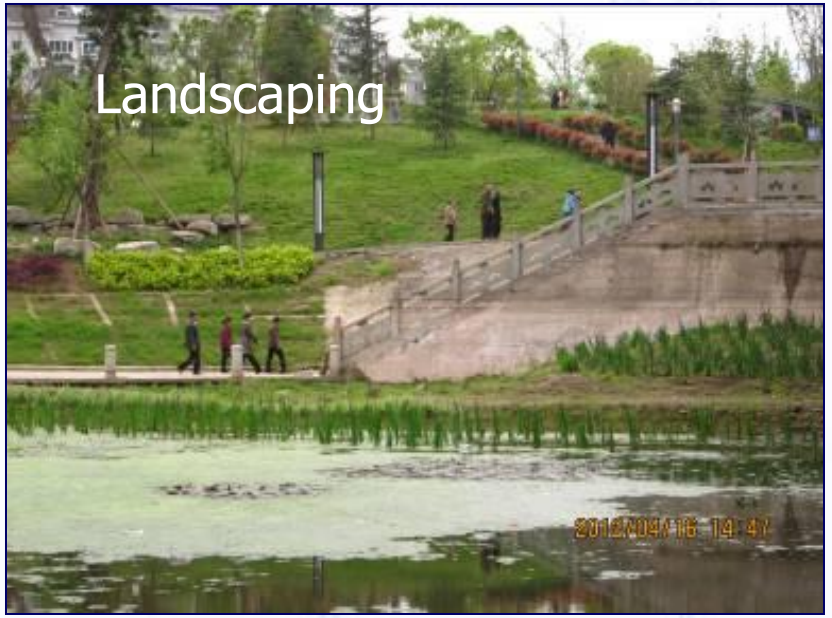


Wire grass
(Cynodon dactylon)

Reduction of biodiversity

Invasio
(Xanthi

Degradation of water quality



Examples of conflicts between various requirements for the drawdown zone

Approach

Eco-friendly use of the drawdown zone of the TGR

- Experiments on dike-pond engineering conducted
- “Design of the dike-pond system in the littoral zone of a Tributary in the Three Gorges Reservoir, China” published in Ecological Engineering (2011) **37(11):** 1718-1725

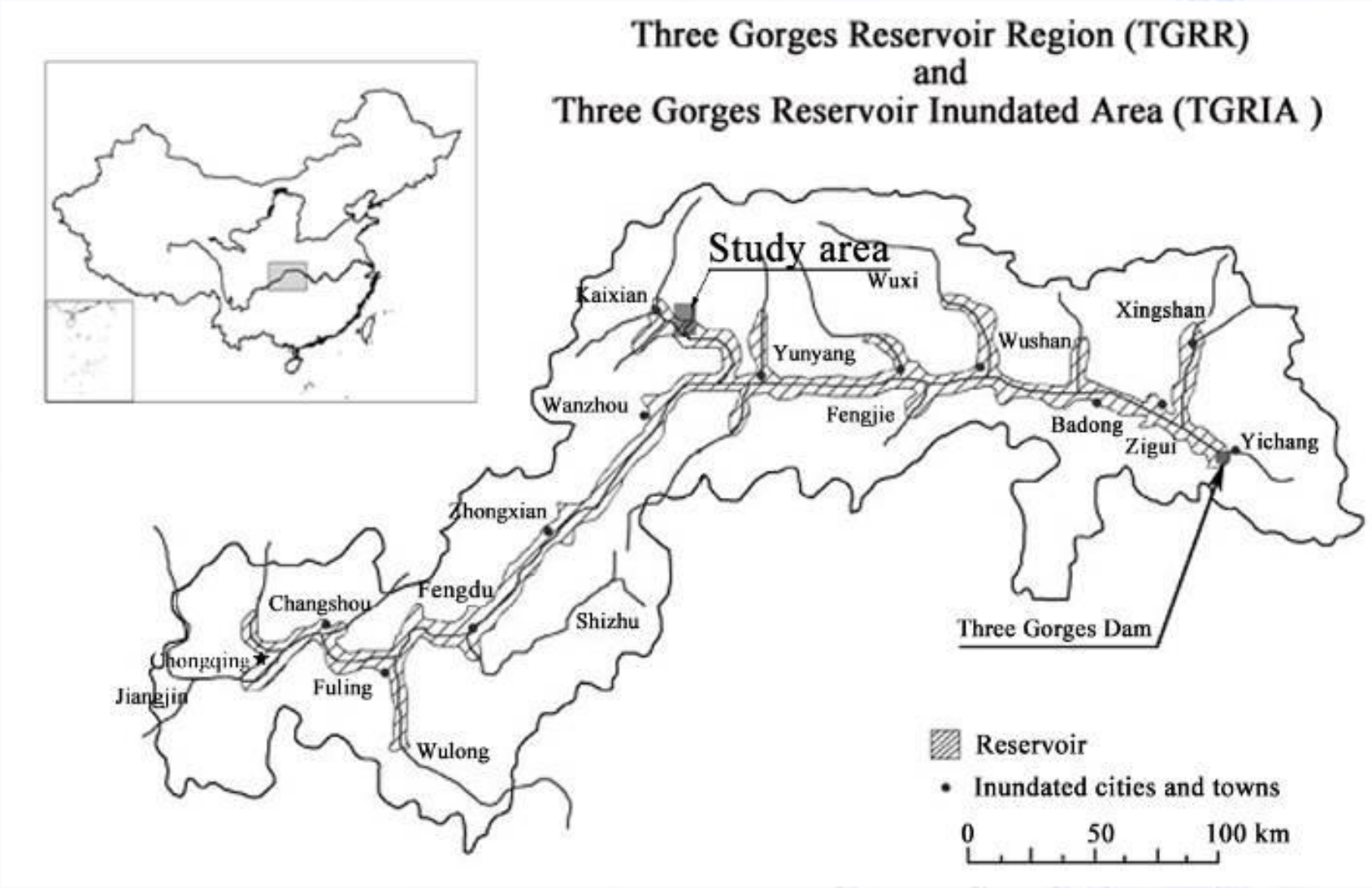
Dike-pond engineering

- An important agriculture heritage in China, as exemplified by the mulberry fish pond systems of the Pearl River Delta in China, which have been in use for more than 400 years

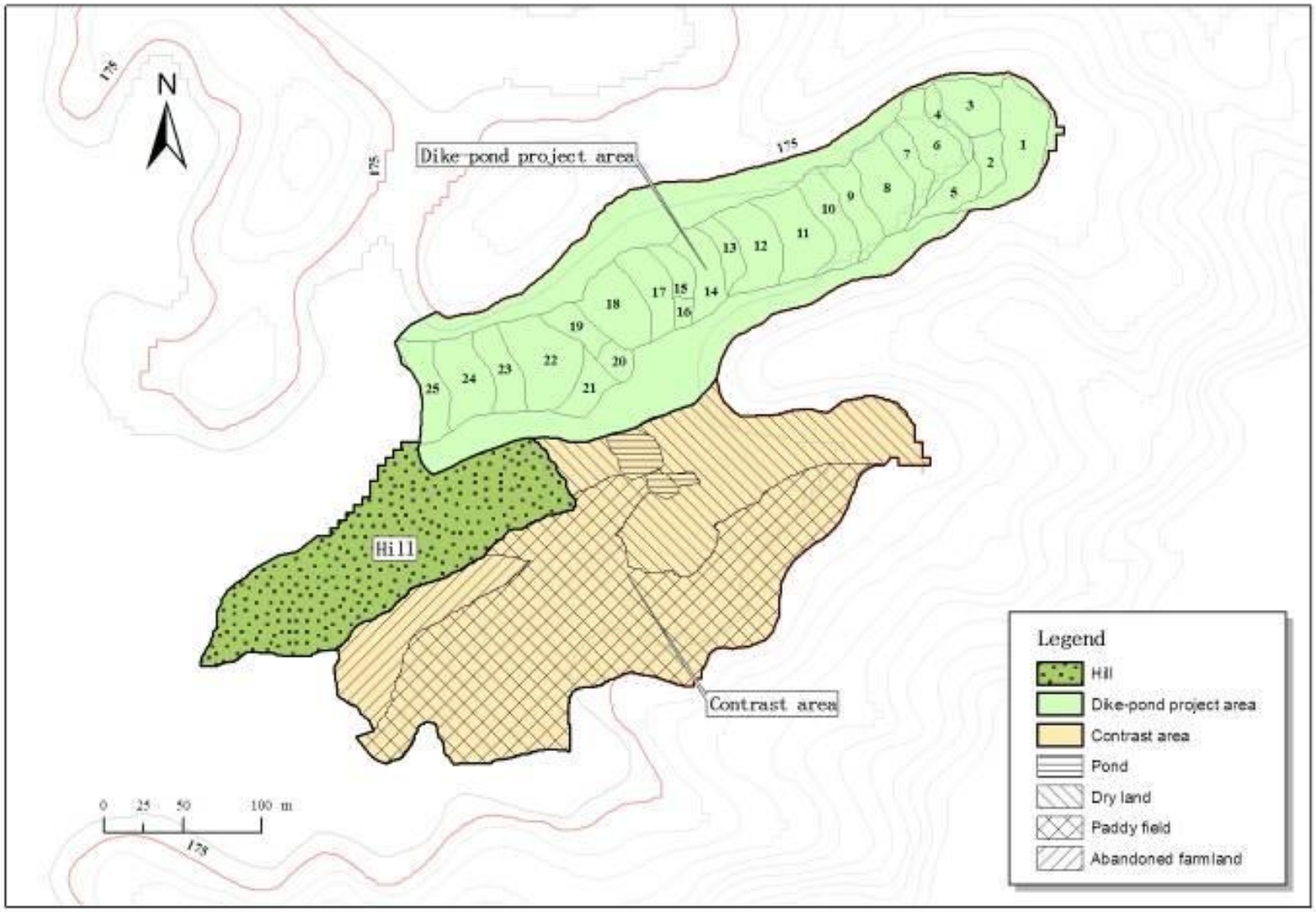

Baijia Wetlands research site, April 2012

- After examining the drawdown zone, a 4.29 ha dike-pond experimental area was set up near the Pengxi River of Kai County.
- Ecological engineering principles were applied.
- A study of ecological and economic effects of dike-pond engineering at Baijia Creek was initiated in 2011.
- A 4.34 ha traditional-use agriculture zone near the dike-pond project was selected for experimental comparison.

Location of the study area in the Three Gorges Reservoir



Sketch map of study area at Baijia Creek




Dike-pond project area in summer


Dike-pond project area in winter, December 2010


The contrast area


Contrast area in December 2010

- Ecological and economic indicators of the status of the project area and contrast area were assessed. The results showed that the dike-pond project created suitable habitat for wetland animals.
- Products having market economic value were acquired in both cases.
- Ecosystem service values have not been assessed formally but may be greater in the dike-pond system.

Plant species in the study area

- 29 species of plants in the dike-pond project area, among which were 14 species of aquatic plants
- 34 species of plants in the contrast area, among which were 11 species of aquatic plants

Part of the plant species table

Scientific name	*Genera*	Family	Ecotype	Distribution	
				Project area	Contrast area
Acalypha australis	*Acalypha*	Euphorbiaceae	mesophyte		√
Acorus calamus	*Acorus*	Araceae	helophyte	√	
Aeschynomene indica	*Aeschynomene*	Fabaceae	mesophyte		√
Alternanthera sessilis	*Alternanthera*	Amaranthaceae	mesophyte	√	√
Amaranthus tricolor	*Amaranthus*	Amaranthaceae	mesophyte	√	√
Artemisia codonocephala	*Artemisia*	Asteraceae	xerophyte	√	√
Aster subulatus	*Aster*	Asteraceae	mesophyte		√
Bidens pilosa	*Bidens*	Asteraceae	mesophyte	√	√
Ceratophyllum demersum	*Ceratophyllum*	Ceratophyllaceae	hydrophyte		√
Commelina communis	*Commelina*	Commelinaceae	mesophyte	√	
Conyza japonica	*Conyza*	Asteraceae	xerophyte	√	√
Cynodon dactylon	*Cynodon*	Gramineae	xerophyte	√	√
Cyperus difformis	*Cyperus*	Cyperaceae	helophyte	√	
Cyperus rotundus	*Cyperus*	Cyperaceae	mesophyte		√
Digitaria sanguinalis	*Digitaria*	Gramineae	xerophyte	√	√
Echinochloa crusgali var. mitis	*Echinochloa*	Gramineae	helophyte	√	√
Eclipta prostrate	*Eclipta*	Asteraceae	helophyte	√	√

17 species of aquatic insects were found in the dike-pond project area; 1.3 times the number in the contrast area

Order	family	species	Distribution	
			Project area	Contrast area
Coleoptera	Dytiscidae	*Cybister*	√	
Coleoptera	Dytiscidae	*Hyphydrus*	√	
Coleoptera	Dytiscidae	*laccophilus*	√	√
Coleoptera	Dytiscidae	*Rhantus*	√	
Coleoptera	Eumolpidae	*sp.*	√	
Coleoptera	Haliplidae	*Haliplus*	√	
Coleoptera	Hydrophilidae	*Berosus*	√	√
Coleoptera	Hydrophilidae	*Laccobius*	√	√
Coleoptera	Hydrophilidae (larva)	*sp.*		√
Decapoda	Atyidae	*Caridina nilotica gracilipes*	√	√
Diptera	Stratiomyidae	*Stratiomyia*	√	
Ephemeroptera	Baetidae	*Cloeon dipterum*	√	√
Hemiptera	Belostomatidae	*Kirkaldyia deyrollei*		√
Hemiptera	Miridae	*sp.*		√
Hemiptera	Naucoridae	*sp.*	√	
Hemiptera	Nepidae	*Laccotrephes japonensis*	√	
Heteroptera	Corixidae	*Micronecta quadriseta*	√	√
Heteroptera	Notonectidae	*Enithares sinica*	√	√
Odonata	Coenagrionidae	*Caenagrion (larva)*	√	√
Odonata	Corduliidae (larva)	*sp.*		√
Odonata	Libellulidae (larva)	*sp.*	√	√


Aquatic insect investigation

Similar contrasts were found for terrestrial insects and birds

- 32 species of terrestrial insects in dike-pond area versus 34 species in contrast area
- 16 species of birds in dike-pond area versus 11 species in contrast area


Little egrets and herons using the experimental dike-pond habitat

Economic assessments


Lotus survives prolonged winter flooding
in the dike-ponds at depths to 20 metres


Plot preparation by plowing conducted in April


Lotus planting


Weeding was conducted in May; no pesticides were used

Lotus root has market value


Arrowhead


Water bamboo

Water chestnut

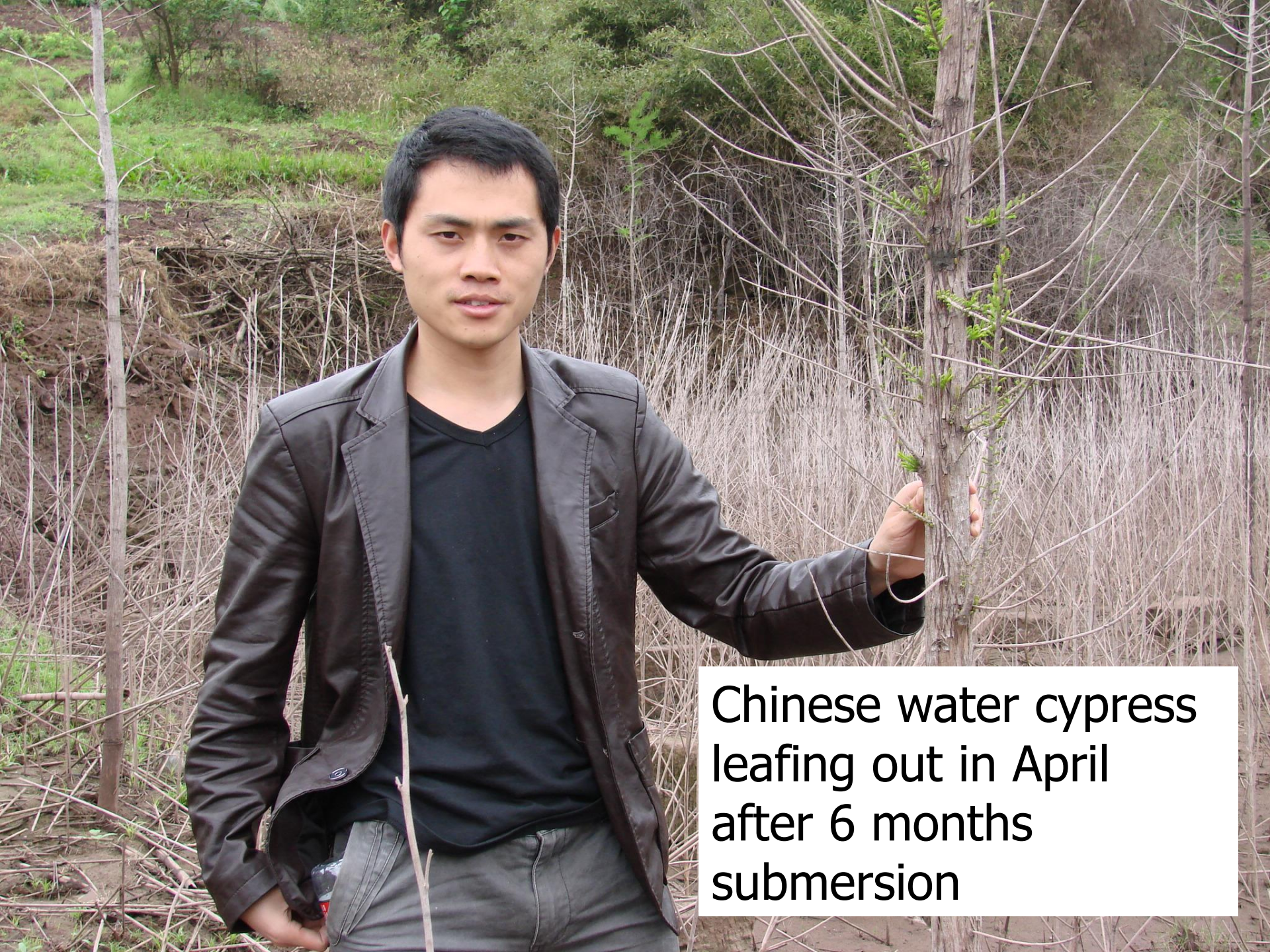
Estimates of hydrophyte costs and production in the dike-pond project

Hydrophyte	Planting area (m^2)	Density (kg/m^2)	Seedling price (¥/kg)	Cost (¥)	Yield (kg/ha)	Production (kg)	Product price (¥/kg)	Sale proceeds (¥)
E. dulcis	1278.07	0.03	6.00	230.05	6180	789.85	6.00	4739.08
I. aquatica[a]	747.90	25.00	0.05	934.87	45000	3365.55	3.00	10096.65
N. nucifera[r,b]	2493.57	0.23	10.00	5735.21	20400	5086.88	6.00	30521.30
N. nucifera[f,c]	5792.17	0.38	10.00	22010.24	1555.5	900.97	50	45048.60
O. sativa	2413.86	0.01	40.00	965.54	9000	2172.47	2.50	5431.19
O. javanica[d]	1687.65	0.23	3.00	1164.48	-	-	-	-
S. trifolia var. *sinensis*	2579.24	0.08	8.00	1650.71	5805	1497.25	8.00	11977.99
T. bispinosa	1443.65	0.03	20.00	866.19	10125	1461.70	10.00	14616.96
Z. Latifolia[a]	1393.24	1.50	1.00	2089.86	7500	1044.93	6.00	6269.58

[a] The unit of density was seedling per m^2, and the unit of seedling price was yuan per seedling.
[b] *N. nucifera*[r] (root-abundant variety) were planted in the first year and the root can be gathered the following year.
[c] Production of *N. nucifera*[f] (flower-abundant variety) was measured as dried lotus seed.
[d] *O. javanica* grew badly because weeds were hard to control

Assessments of many ecological-economic values have not yet been completed; such as value of woody plants for stabilizing slopes

- *Salix matsudana* survives moderate flooding, but experiments not yet conducted
- Chinese water cypress survives complete submersion
- Mulberry (*Morus alba*) survives moderate flooding provided the top of the plant is above water


Chinese water cypress leafing out in April after 6 months submersion