Water related Ecosystem Service in the paddy-upland rotated and irrigated area of Chengdu plain——case study in Pidu District

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Criteria of GIAHS——ecosystem service

- ES: benefits people could get from ecosystem

ES categories	内涵
providing	food, fiber, fuel, wood, natural, medicine
regulation	climate moderation, erosion regulation, water purification
culture	spiritual enrichment, cognitive development, reflection, recreation, aesthetic experiences
support	Photosynthesis, pollination, habitat, nutrient cycling, hydrological cycling

TARGET
to sustainably obtain ES

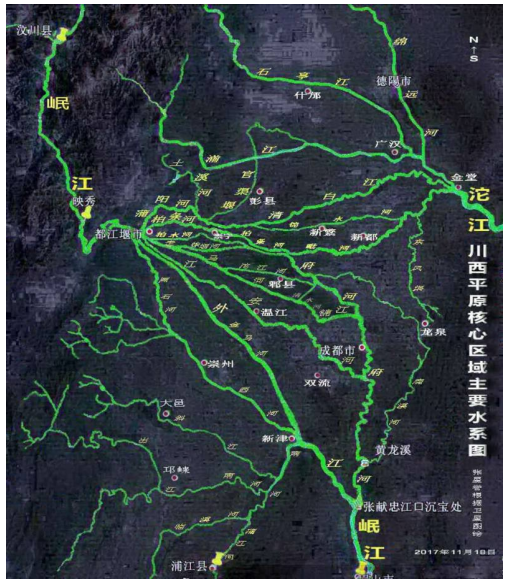
METHOD
Trade off, management of ES

Study Area——Pidu District, Chengdu city

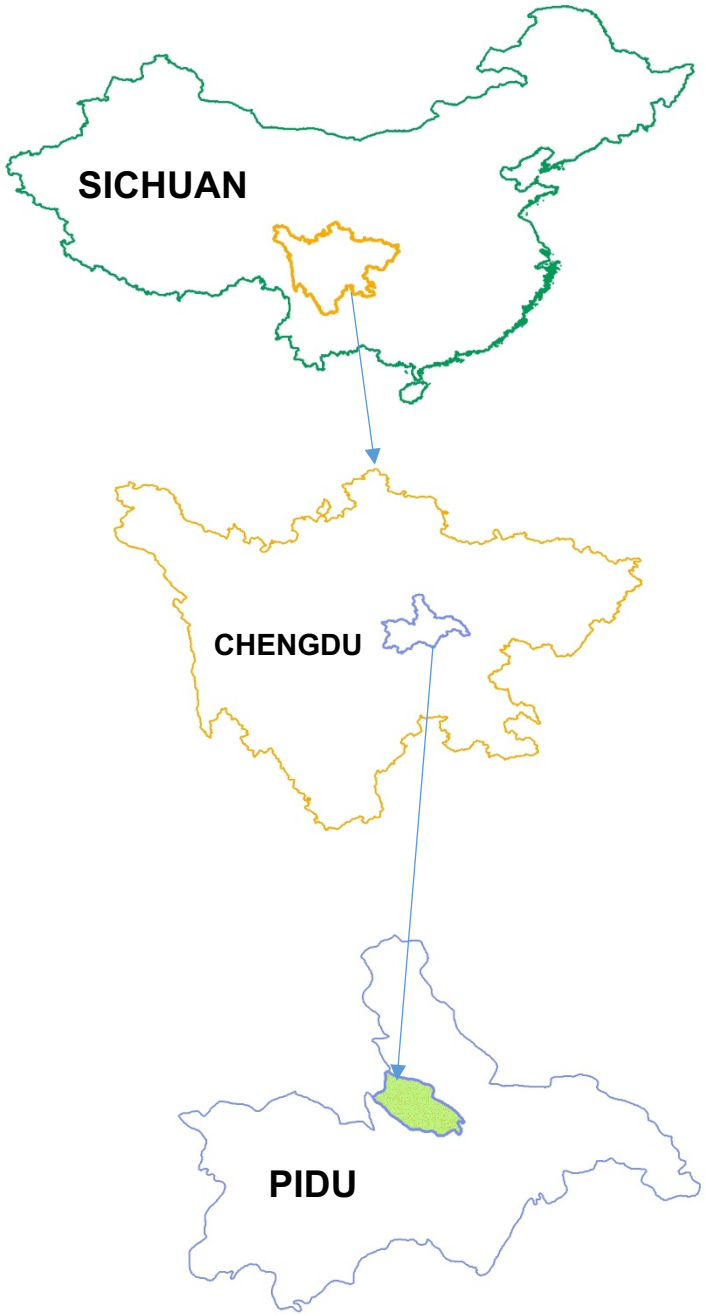
- **LOCATION:** in the southeast part of Chengdu city, in the central section of Chengdu plain
- **HISTORY:** 2700 years, used to be the capital of the country “SHU蜀”
- **BASIC CONDITION:** 15 villages, total area 437.5KM^2, farmland 133.4KM^2, nursery stock 66.7KM^2, the “vegetable basket of Chengdu ”,also the “water resource of Chengdu ”

valve

Hotbed chives

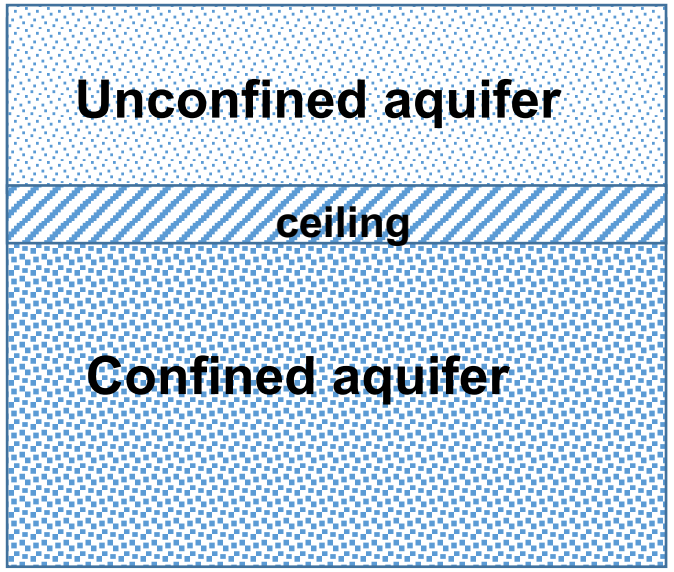


River system of Pidu



Geology & Geomorphology

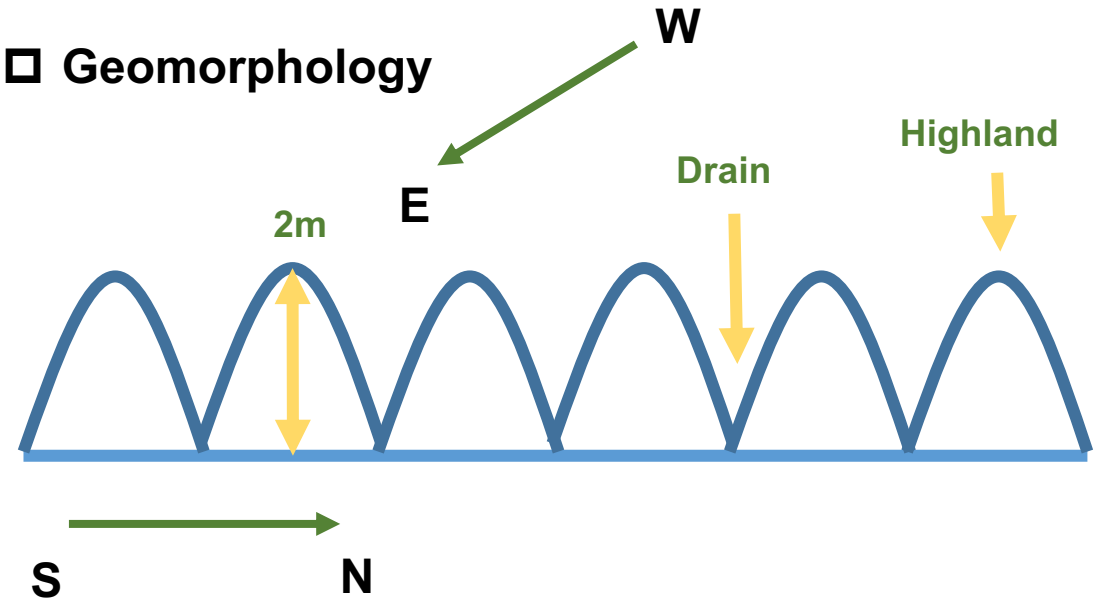
Geology



Located between the first and the second terraces of the proluvial fun of Min River

Forming its unique soil structure

Geomorphology



Applicable for both paddy and vegetables

- 3 main type of geomorphology
  - mesas：upper soil layer is reticulate clay, glutenite in the lower layer。
  - Fan-shaped plain：biggest ratio， upper soil layer is grey paddy soil, lower layer is silty sand
  - Floodplain level terraces：1~3m thick Clay or Asian clay in the upper layer

Pattern of paddy-upland rotation in Pidu

- **Rotation**

  Crop-vege-vege-(vege…)

- **High diversity**

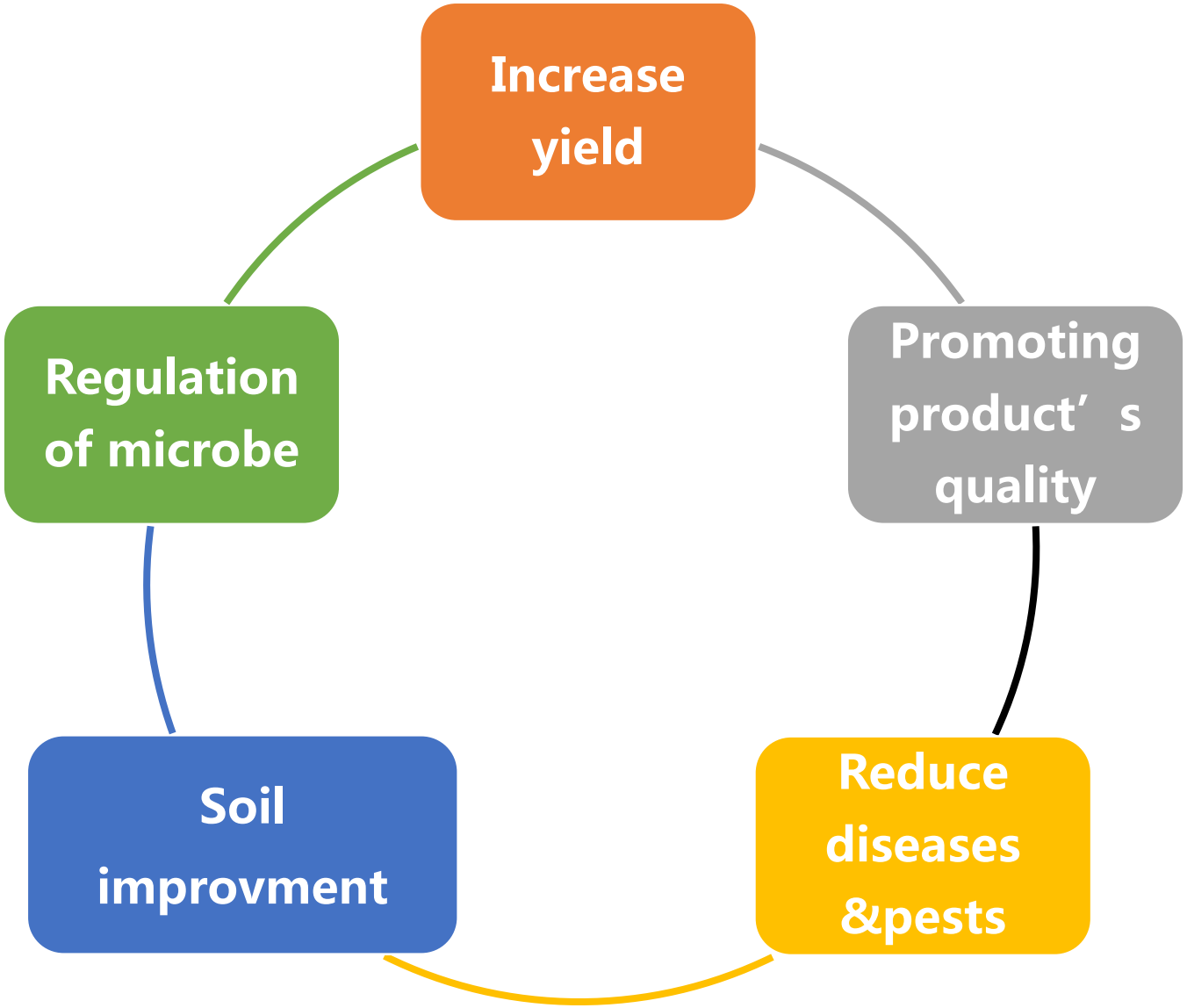
  80+ varieties

- **High yield**

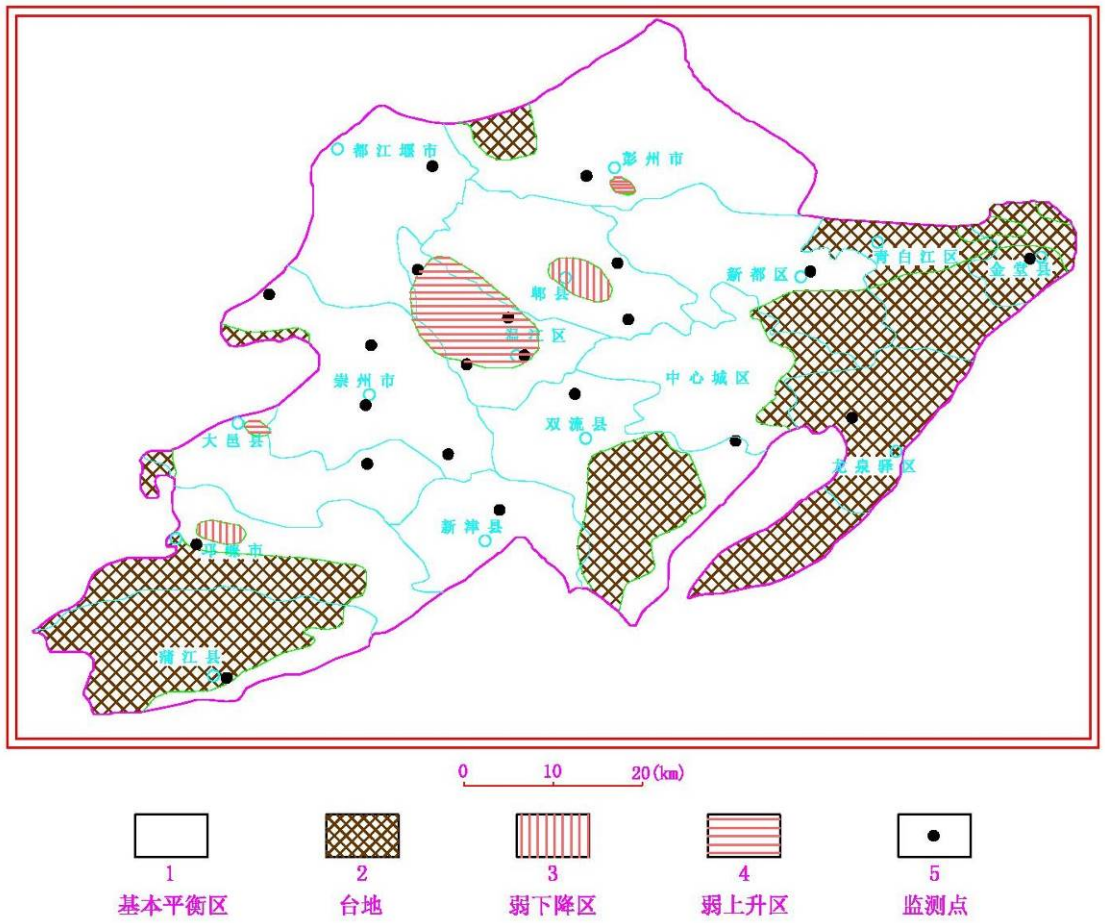
——8.1W CNY/a income on average

	Spring	Summer	Autumn & Winter	All year
vegetables	Indian Rorippa Herb, potato, Chinese cabbage	Vine, Indian Rorippa Herb、white gourd, eggplant, sponge gourd, chayote, balsam pear, 、pumpkin, zucchini, maize, kale, cucumber, tomato, water spinach, round-root radish, red-skin-radish, 、kohlrabi, chili, oil skin food, soybean, mung bean , red bean, vigna sinensis, dolichos lablab, kidney bean, cuisine, basella alba, wild rice stem, daylily, ginger, edible amaranth, lotus root, taro	Ercai ， tuber mustard, cabbage, Chinese cabbage, garlic bolt, young garlic shoot, garlic, kohlrabi, kale, brassica campestris, potherb mallow, oil skin food, pak choi, tine pea, rape brassica, tobacco, spinach	Asparagus lettuce, broccoli, cauliflower, celery, hotbed chives, fragrant-flowered garlic, allium fistulosum, kale, coriander, 、zheergen, mushroom、

paddy-upland rotation ——supply & regulation



Regulation of underground water



- **Water quantity**：basically balance
- **Water quality**：few section has high level of NH_4^+, NO_3^-, NO_2^-（3N）

- **3N in underground water**

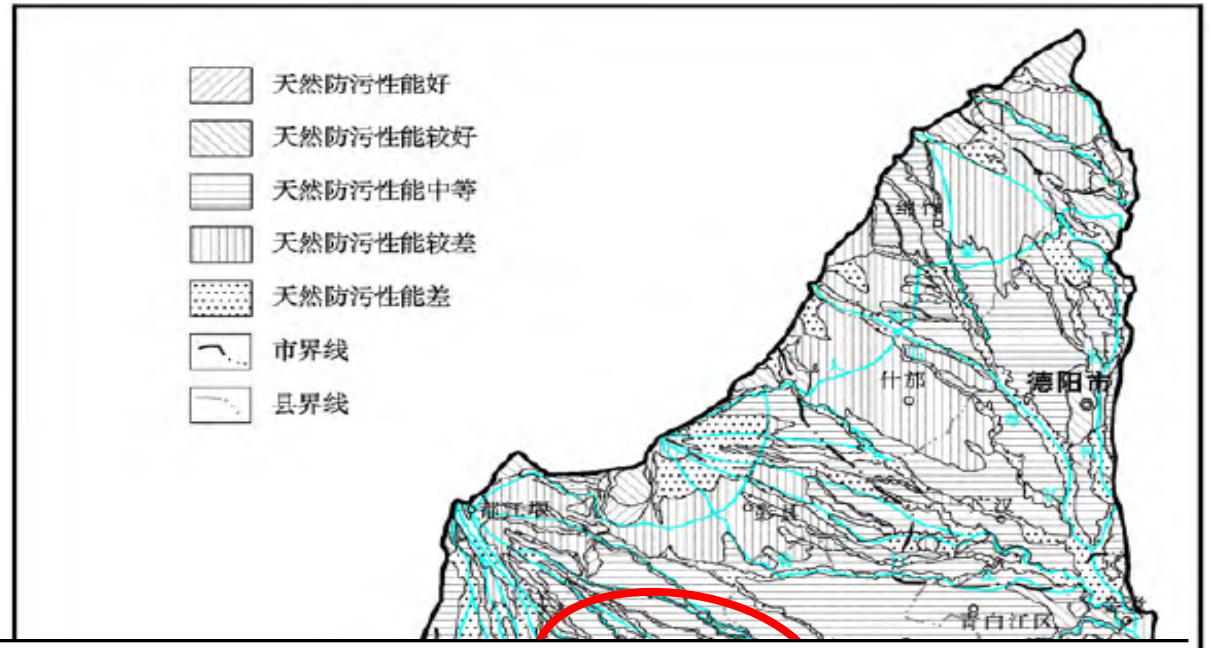
  mainly comes from agriculture(leaking in the field)

  especially in summer-----high rainfall + high fertilization

Characteristic of field leaking in Pidu

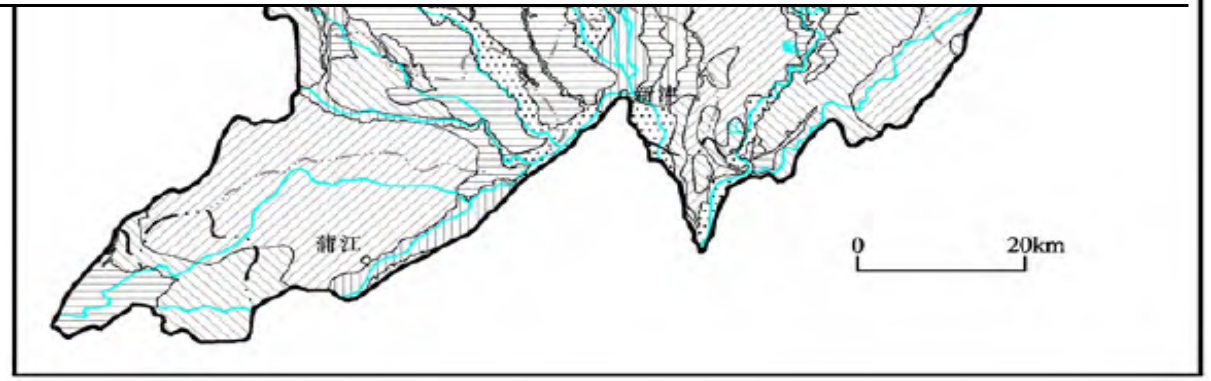
- DRASTIC model(American ） ,
  seven factor : Depth of water table、Net recharge、Aquifer media、Soil media、Topography、Impact of Vadose Zone and Hydraulic Conductivity.

----------Assessment for the characteristic of leaking



month	1	2	3	4	5	6	7	8	9	10	11	12	Annual rainfalll
Annual average （1980~2012）	8.5	13.5	23.7	46.6	74.0	105.3	225.4	201.6	140.4	38.7	18.1	5.2	901.0

- Rainfall in summer covers 75% of the annual rainfall
- Pick 2015 as the typical year



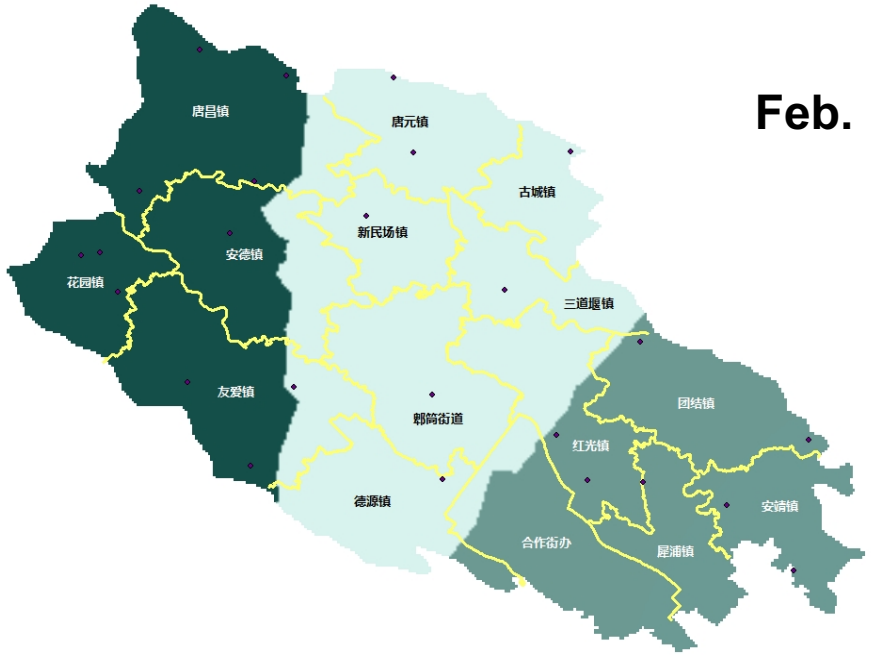
Underground water quality

- **Kriging interpolation**

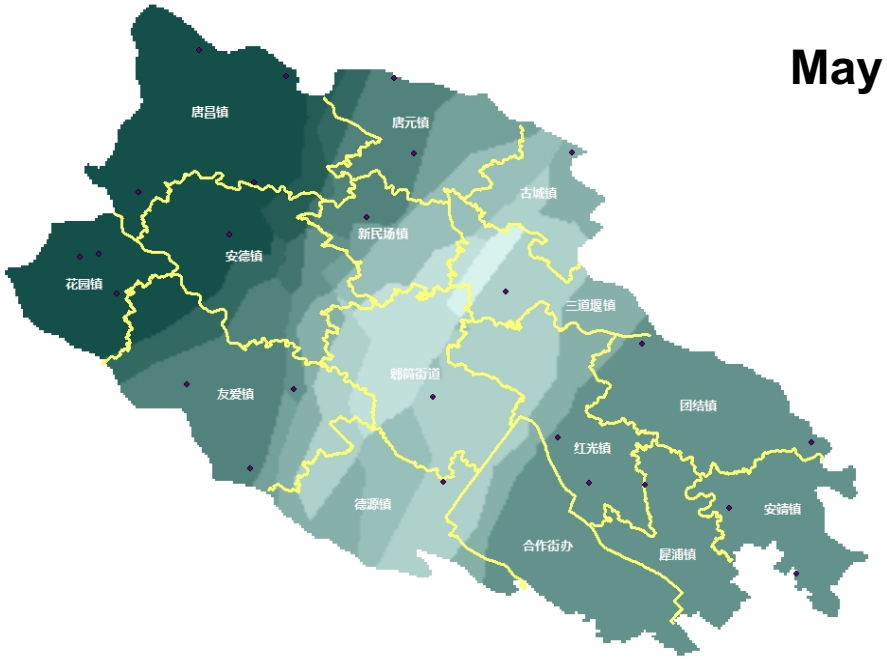
$$\gamma(h) = c \cdot Sph\left(\frac{h}{a}\right) = \begin{cases} 0 & h = 0 \\ c \cdot \left[\frac{3}{2}\frac{h}{a} - \frac{1}{2}\left(\frac{h}{a}\right)^3\right], & h \le a \\ c & h \ge a \end{cases}$$

arcgis10.2 spatial analysis

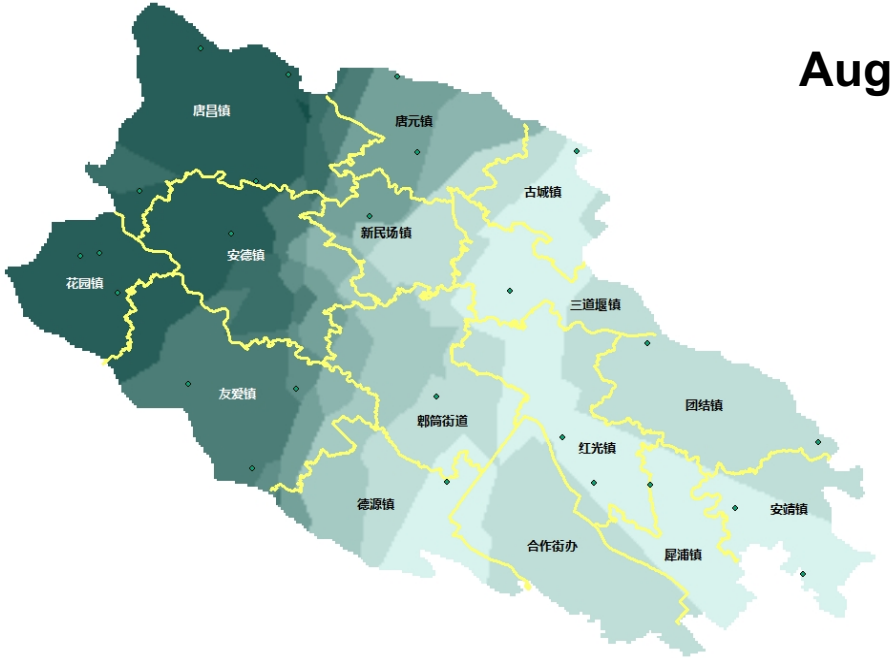
编号	地理位置	坐标	
		纬度	经度
PX01	郫都区唐昌镇唐昌水厂	30° 56′ 11.046″	103° 49′ 23.520″
PX02	郫都区唐昌镇新胜水厂	30° 53′ 33.789″	103° 46′ 00.862″
PX03	郫都区花园镇花园新水厂	30° 52′ 06.685″	103° 44′ 39.750″
PX04	郫都区友爱镇农科村友爱支渠	30° 49′ 13.787″	103° 47′ 06.628″
PX05	郫都区安德镇安德水厂	30° 52′ 37.264″	103° 48′ 05.883″
PX06	郫都区唐元镇唐元水厂	30° 54′ 27.045″	103° 52′ 21.247″
PX07	郫都区新民场镇新民场水厂	30° 52′ 59.941″	103° 51′ 15.680″
PX08	郫都区唐昌镇留驾电厂	30° 53′ 47.001″	103° 48′ 39.532″
PX09	郫都区三道堰镇鑫鸿基食品厂	30° 51′ 20.042″	103° 54′ 27.819″
PX10	郫都区古城镇花牌村	30° 54′ 28.340″	103° 55′ 58.672″
PX11	郫都区团结镇石堤水厂	30° 50′ 09.020″	103° 57′ 36.291″
PX12	郫都区安靖镇林湾水厂	30° 46′ 26.687″	103° 59′ 35.670″
PX13	郫都区团结镇污水处理厂	30° 47′ 55.500″	104° 01′ 28.635″
PX14	郫都区唐昌镇战旗社区	30° 56′ 46.271″	103° 47′ 24.294″
PX15	郫都区花园镇郫花路蔡家点	30° 51′ 17.243″	103° 45′ 30.651″
PX16	郫都区唐元镇天星村亚克力	30° 56′ 09.273″	103° 51′ 52.943″
PX17	郫都区友爱镇何家场社区	30° 47′ 20.970″	103° 48′ 35.228″
PX18	郫都区友爱镇达盛光学公司	30° 49′ 07.844″	103° 49′ 35.048″
PX19	郫都区花园镇隆裕村委会	30° 52′ 10.683″	103° 45′ 05.456″
PX20	郫都区郫筒港通北二路宏图电器	30° 48′ 03.135″	103° 55′ 39.945″
PX21	郫都区郫筒老西街水务局家属区	30° 48′ 56.696″	103° 52′ 46.551″
PX22	郫都区红光镇家园街佳苑市场	30° 47′ 00.901″	103° 56′ 22.527″
PX23	郫都区德源镇兴东兴管业公司	30° 47′ 02.844″	103° 53′ 00.830″
PX24	郫都区犀浦镇西华大学东门	30° 46′ 58.510″	103° 57′ 40.152″
PX25	郫都区安靖镇海霸王路食品市场	30° 44′ 58.390″	104° 01′ 09.311″



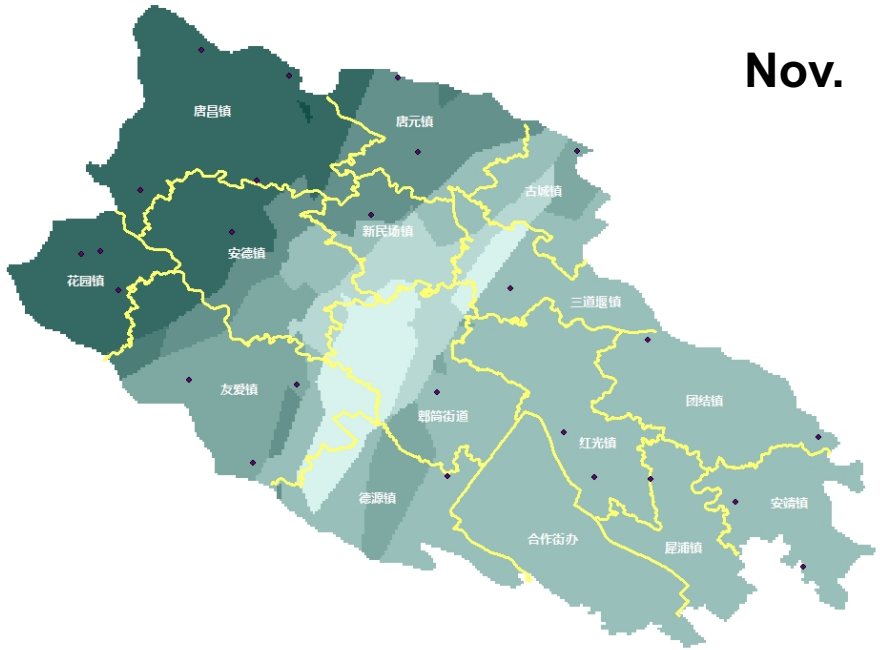
Feb.



May



Aug.



Nov.

Seepage amount

Traditional

summer（6月~9月）：paddy field (100%)

Other seasons（10月~5月）：wheat/rape (100%)

Contemporary

summer（6月~9月）：paddy field(50%)+vegetable(50%)

Other seasons（10月~5月）：vegetable(100%)

➢ Two questions

- Under traditional model，the utilize OR recharge amount of summer-paddy and other season-vegetable?
- Under contemporary model, the utilize OR recharge amount of summer-paddy and other season-vegetable?

Spot investigation

Irrigation regime

2~3 times in other seasons，1~2 times per season

6 times in summer，（6月15~7月初，10cm）

Drainage regime

summer: by controlling the height of sluice

Other season: almost no drainage

Calculation

Penman formula

$$ET_o = \frac{0.408\Delta(R_n - G) + \gamma \frac{900}{T+273} u_2 (e_s - e_a)}{\Delta + \gamma(1 + 0.34u_2)}$$

$$ET_C = ET_0 \times K_c$$

Data

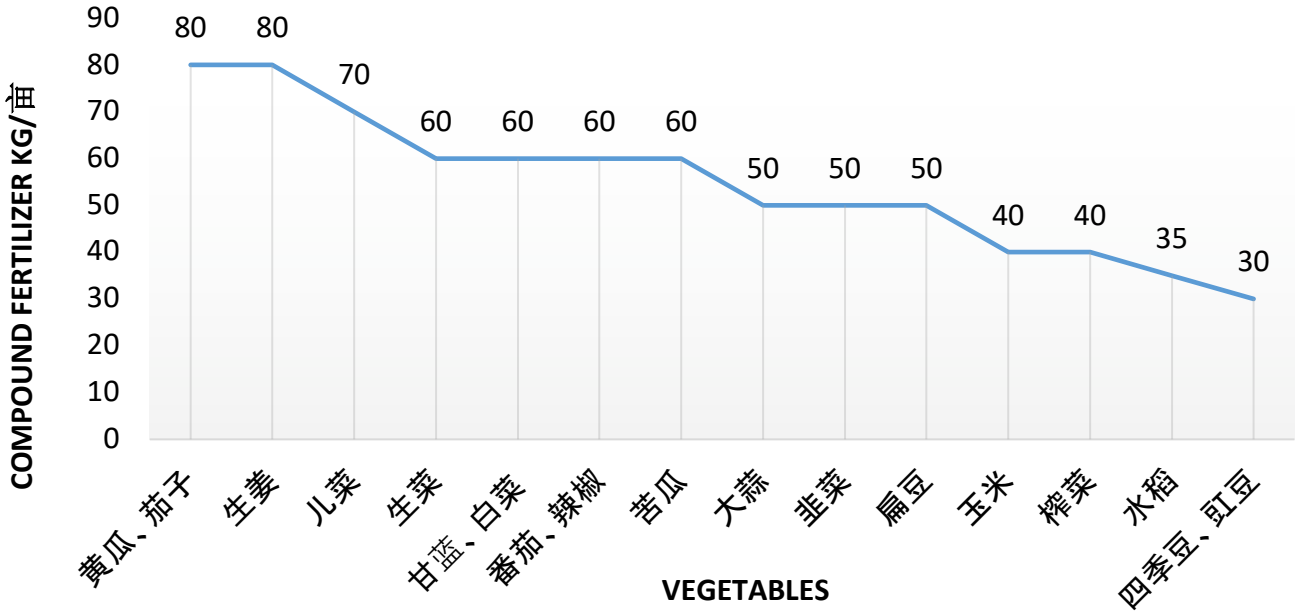
- 2015 meteorology data：Tmax, Tmin, T, shineshine hours, humidity, wind velocity at 10m, wind velocity at 2m,atmospheric pressure, net radiation,rainfall
- 《FAO PAPER 56》reference crop coefficients

Seepage amount

Main vegetable area

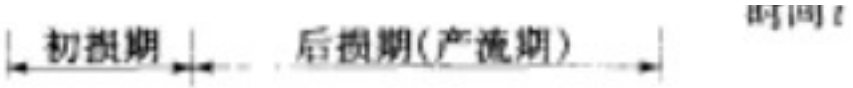
作物	area/亩	作物	area/亩	作物	area/亩	作物	area/亩
大蒜	2W	生菜	5K	苦瓜	3K	大葱	1K
韭黄	2W	榨菜	5K	黄瓜	3K	土豆	500
儿菜	3W	大白菜	5K	豇豆	1K		
棒菜	1W	生姜	5K	四季豆	1K		
甘蓝	1W	番茄	5K	旱烟	1.2K		
			3K	芹菜	1K		

Fertilizer of different vegetables



verage of Kc=0.75

- Summer-paddy，recharge162mm
- Other seasons-veg，utilize 42.2mm
- Summer-veg，recharge147mm



CONCLUSION

- **Planting any crop in summer could recharge underground water，but paddy is little higher than vegetables.**
- **Planting in other seasons will utilize underground water.**
- **Paddy has less fertilizer seepage than vegetables in summer.**
- **Planting in traditional rotation mode is better than the contemporary one for underground water regulation service, both quality and quantity.**

Underground water in Pidu → **Domestic water**

- **Management measure**

Conserve the traditional rotation mode

Keep traditional land use style

→

- **Management target**

Improve the supplying and regulation service on underground water

THANKS!

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