# Relations between Water Rights System and Economic and Social Development in History
## —A Study of the Tongli Canal in Hongtong County

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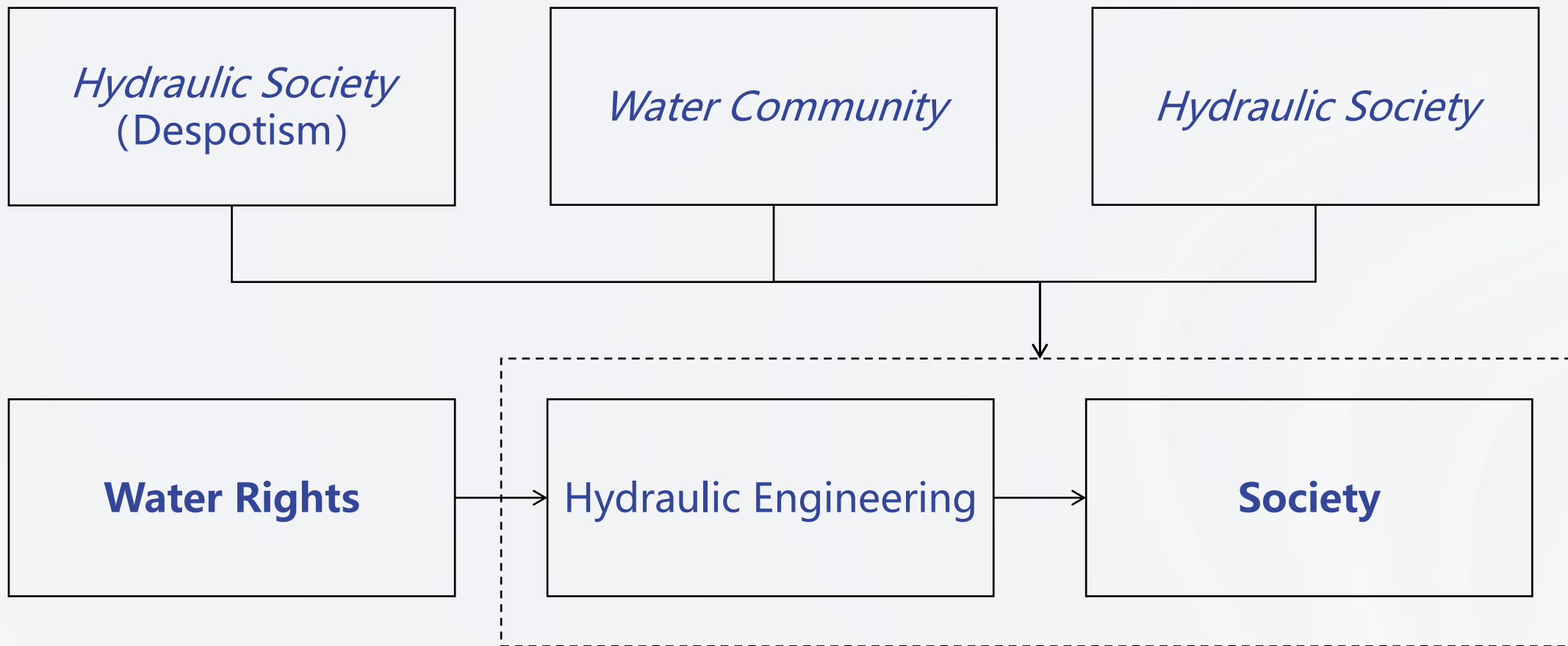
- **Social-Ecological System**

- **Conclusion**

Fig. 1 Relations between water rights and society

- The largest canal that channel river water for irrigation in Hongtong county and even in Shanxi Province.

- Benefitting 18 villages in the late Qing Dynasty and the era of the Republic of China.

**Fig. 2 Tongli Canal in the late Qing Dynasty and the era of the Republic of China***

*Zhou Y., Zhang J. F. Water Conservancy Management and Running in Rural Society of Southern Shanxi Province at the Sunset of the Qing Dynasty———A Study of the Tongli Canal[J]. Agricultural History of China,2005(03):23-30.
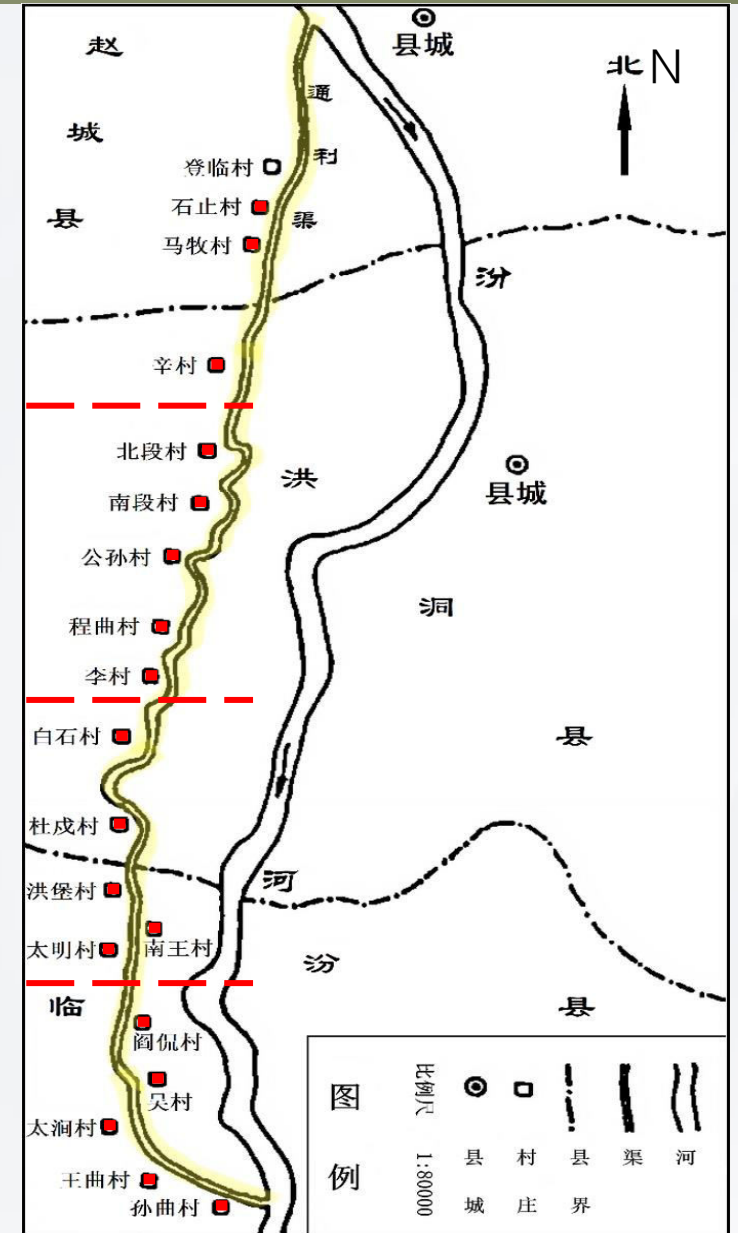
## Water Utilization

- "Watering by license" from the downstream to the upstream.

- For highland, placing waterwheels and wells to get water is allowed.

## Water Distribution

- Distance from the upstream outfall was negatively correlated with watering area per unit of time in each village.

- The total watering time in each village is affected by both the watering area and the distance from the upstream outfall.

**Tab. 1 Watering area and time of the villages in 1396\***

| County | Village | Distance from the upstream outfall (km) | Watering area (km²) | Watering area per unit of time (km²/h) | Total watering time (h) |
|---|---|---|---|---|---|
| Zhaocheng | Shizhi | 14.000 | 0.894 | 0.052 | 17.300 |
| | Mamu | 16.000 | 1.017 | 0.052 | 19.680 |
| Hongtong | Xin | 21.500 | 0.801 | 0.050 | 16.020 |
| | Beiduan | 27.500 | 0.656 | 0.048 | 13.560 |
| | Nanduan | 27.500 | 0.487 | 0.048 | 10.080 |
| | Gongsun | 29.000 | 0.743 | 0.047 | 15.920 |
| | Chengqu | 30.000 | 1.067 | 0.045 | 23.720 |
| | Li&Qingyunguan | 32.500 | 1.059 | 0.045 | 23.540 |
| | Baishi | 35.000 | 0.694 | 0.043 | 16.020 |
| | Dushu | 40.000 | 1.290 | 0.040 | 32.260 |
| Linfen | Beiyanghuang&Yanghuang | 42.500 | 1.091 | 0.034 | 32.100 |
| | Xiyanghuang | 45.000 | 0.121 | 0.032 | 3.840 |
| | Nanwang | 45.000 | 0.940 | 0.032 | 29.680 |
| | Taiming | 50.000 | 0.938 | 0.031 | 30.000 |
| | Yankan | 50.000 | 0.460 | 0.027 | 17.260 |
| | Wu | 50.500 | 0.690 | 0.027 | 25.860 |
| | Taijian | 52.500 | 0.807 | 0.026 | 31.420 |
| | Wangqu | 53.500 | 0.927 | 0.025 | 37.100 |
| | Xicun | 55.000 | 1.113 | 0.023 | 47.680 |
| Total | 21 | | 15.795 | | 443.040 |

*Revised Book of Tongli Canal,1908.

**Management Institution**

- Day-to-day management: 4 canal chiefs, 3 deputy chiefs and 1 supervisor.

- Authority: a temporary organization composed of gentries.

**Engineering**

- Engineering operation: canal mouths and embankments.

- Engineering maintenance: 1 worker for every 30 mu(≈5 acres) of watered land.

**Expense**

- Taxes, labor costs, engineering costs and land purchase costs.

**Sacrifice**

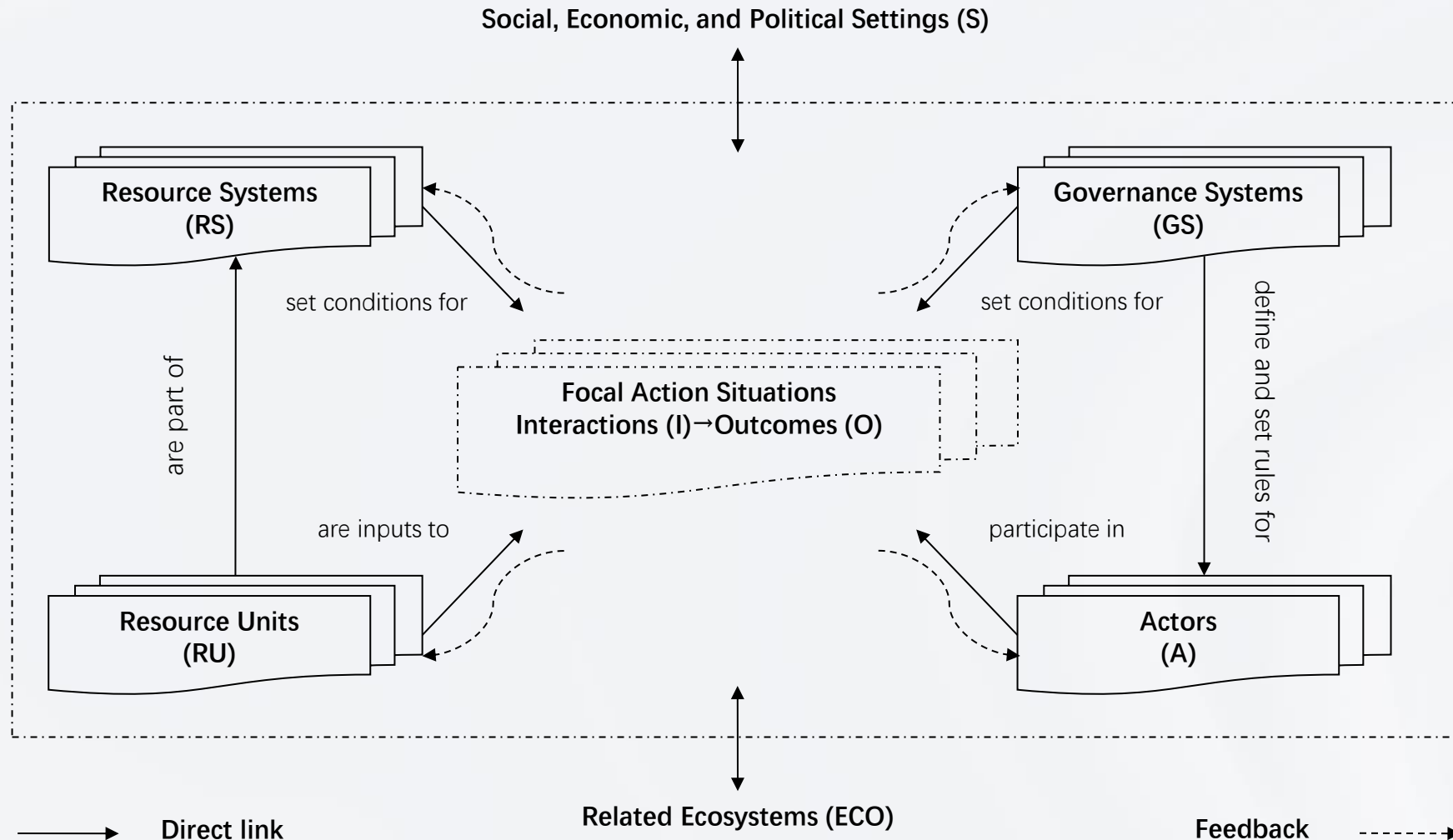- 1 temple for 3 villages upstream and other villages respectively.

**Fig. 3 Revised social-ecological system (SES) framework with multiple first-tier components***

*Mcginnis, M. D., Ostrom, E. Social-Ecological System Framework: Initial Changes and Continuing Challenges[J]. Ecology and Society,2014(19):30.

**Tab. 2 SES variables of water rights system in Tongli Canal**

| First-tier variables | Second-tier variables | Third-tier variables | Fourth-tier variables |
|---|---|---|---|
| Governance systems (GS) | GS4 Property-rights systems | GS4-1 Water distribution systems | GS4-1-1 Water distribution systems for irrigation |
| | | | GS4-1-2 Water distribution systems for water mill |
| | GS5 Operational-choice rules | GS5-1 Water utilization systems | GS5-1-1 Water utilization systems for irrigation |
| | | | GS5-1-2 Water utilization systems for water mill |
| | | GS5-2 Management institution systems | |
| | | GS5-3 Engineering systems | |
| | | GS5-4 Expense systems | |
| Actors (A) | A6 Norms (trust-reciprocity)/social capital | A6-1 Sacrifice systems | |

## Tab. 3 SES variables of economic and social development in Tongli Canal

| First-tier variables | Second-tier variables | Third-tier variables | Fourth-tier variables |
|---|---|---|---|
| Social, economic, and political settings (S) | S1 Economic development | | |
| | S2 Demographic trends | | |
| | S3 Political stability | | |
| Resource systems (RS) | RS4 Human-constructed facilities | RS4-1 Destruction of the canal | |
| | | RS4-2 Repairation of the canal | |
| | RS5 Productivity of system | RS5-1 Scarcity of water resources | |
| | RS7 Predictability of system dynamics | RS7-1 Natural disasters | |
| | RS9 Location | | |
| Governance systems (GS) | GS1 Government organizations | | |
| Resource units (RU) | RU2 Growth or replacement rate | RU2-1 Changes in water resources | RU2-1-1 Decrease in water resources |
| | | | RU2-1-2 Increase in water resources |
| | | RU2-2 Changes in cropland area | RU2-2-1 Decrease in cropland area |
| | | | RU2-2-2 Increase in cropland area |
| Actors (A) | A1 Number of relevant actors | | |
| | A2 Socioeconomic attributes | | |
| | A4 Location | | |
| | A5 Leadership/entrepreneurship | | |
| | A6 Norms (trust-reciprocity)/social capital | A6-2 Other norms (trust-reciprocity) | |
| | A7 Knowledge of SES/mental models | | |
| | A8 Importance of resource (dependence) | A8-1 Importance of water resources (dependence) | |
| Focal action situations: Interactions (I) → Outcomes (O) | I2 Information sharing | | |
| | I4 Conflicts | | |
| | I6 Lobbying activities | | |
| | I9 Monitoring activities | | |
| | O1 Social performance measures (e.g., efficiency, equity, accountability, sustainability) | | |
| Related ecosystems (ECO) | ECO1 Climate patterns | | |

## Tongli Canal water rights system and economic and social development were mutually causal in history.
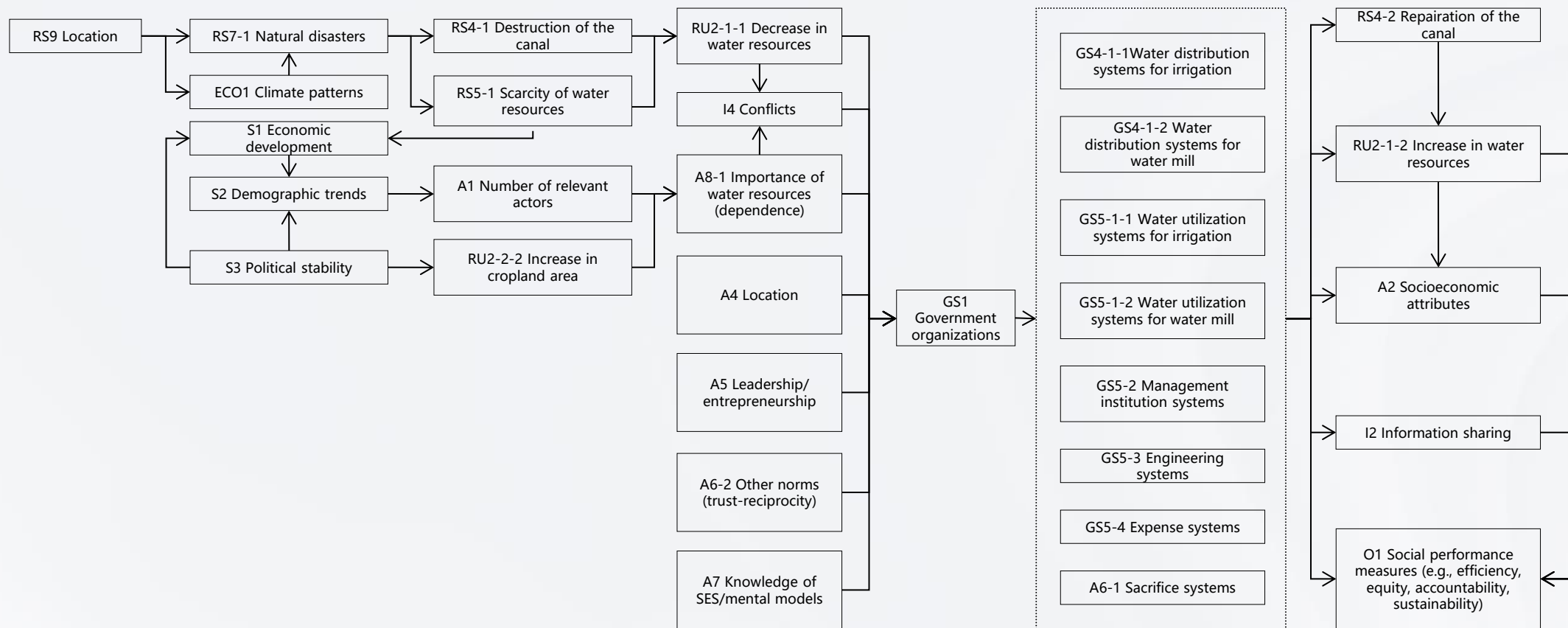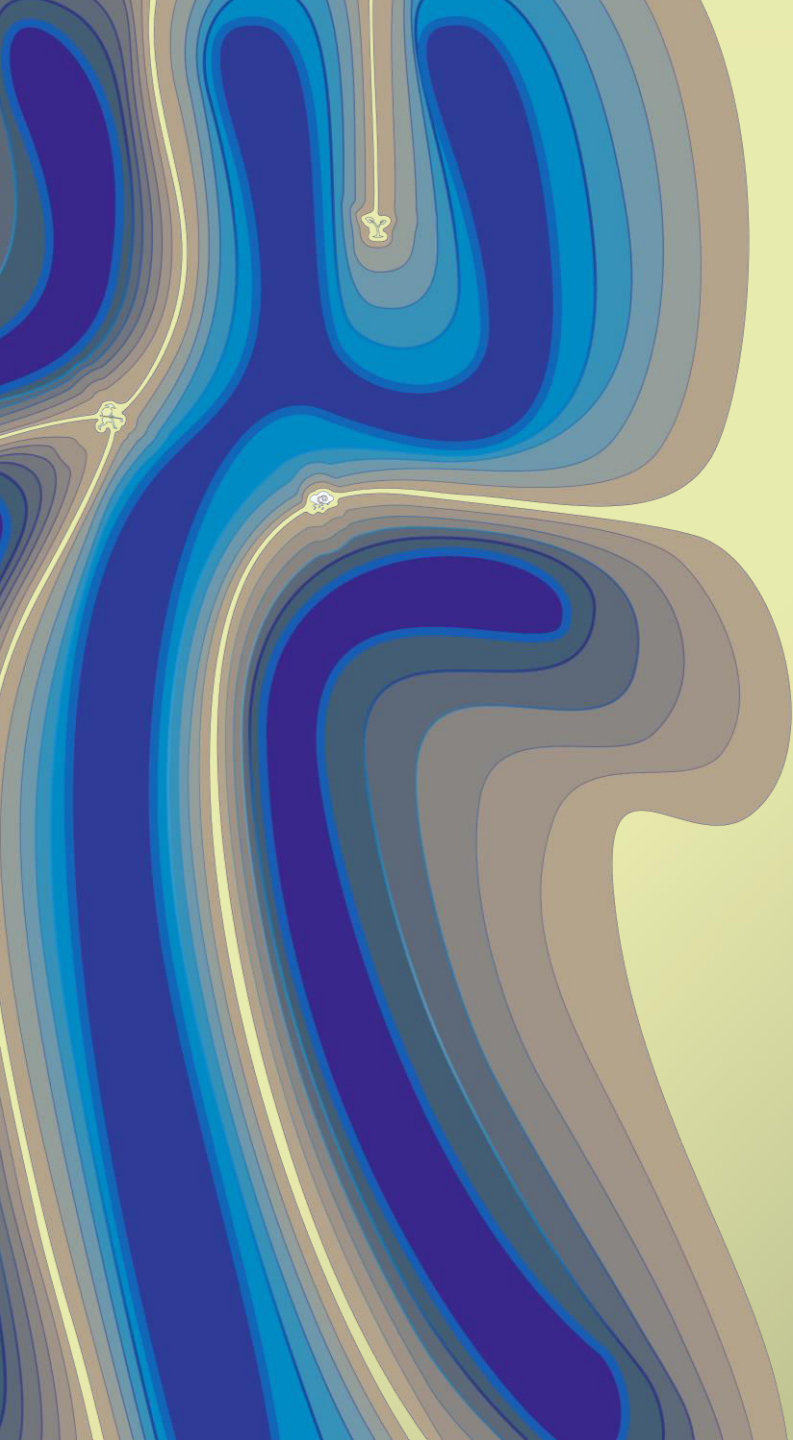


**Fig. 4 Relations among SES variables of Tongli Canal**

# Thanks

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