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Reclaiming the Saline Soils of Nanpi County: Turning Knowledge into Practice

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Abstract

Through studies over five years the authors assessed the health of a catchment in a saline region of Nanpi County in Hebei Province, China using a set of key indicators. The indicators chosen included groundwater table level, electrical conductivity in groundwater, soil colour, pH and consistency. From this assessment they constructed a knowledge transfer network involving the Nanpi Eco-Agricultural Experimental Station, local government, a technical extension station, scientists, technicians and key users.

根据区域农业发展存在的环境问题，利用环境质量评价指标体系，建立了南皮县盐碱地环境质量评价体系。体系的构成包括地下水水位、水质、土壤颜色、土壤 pH 值、土壤紧持度等一系列指标。在指标建立的同时，建立了指标的推广体系。这一体系包括中国科学院南皮生态农业试验站、南皮县政府、南皮县技术推广站、直至农民用户。通过努力，一个持续健康发展的农业体系必将在盐碱地环境下建立。

NANPI County is located in the east of Hebei Province, which is near Beijing and Tianjin on the North China Plain (NCP). The county is 70 km west of the Bohai Sea, at an elevation of 6–13 m. It covers 690 km² and has a population of 320,000. Annual

mean temperature is 11.3°C and mean precipitation is 500–600 mm. Over 70% of annual rainfall occurs in July, August and September. The shallow groundwater table is about 5–8 m below the

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surface; about two-thirds of the shallow groundwater is saline. The deep groundwater table is 60 m below the surface and is declining. Wheat, corn, cotton and Chinese dates are the main cultivated crops of the region. The Overview provides further details about the NCP region; Figure 1 of the Overview shows its location.

The lower reaches of many rivers are located in Nanpi County, so it is a region of salt deposit and accumulation, with a history of problems due to saline soils. Chapter 13 describes the chemical properties of some of the soils in the region. It has been said that in wet seasons the region has only frogs, in dry seasons only locusts and in normal seasons only salt. Until the 1960s, about 30% of the land area was saline. With water shortages, better water engineering and better reclamation of saline soils, the area affected by salinity is rapidly decreasing and now accounts for less than 5% of the land area.

Problems for sustainable agriculture in saline areas of Nanpi County

Although the area of saline soil in Nanpi County has been reduced, the remaining saline area will be more difficult to reclaim because of water deficit and secondary salinity (because the salt in the reclaimed soils has not moved out of the region). In 1995, the Dalangdian reservoir was constructed to provide water from the Yellow River for domestic

and industry use in Cangzhou city. This development will affect the groundwater table and may lead to further soil salinisation. Thus, drought, water deficiency and soil salinity are major problems for the development of sustainable agriculture in Nanpi County. Methods to assess catchment health are needed in order to achieve sustainable agriculture.

Long-term studies on the reclamation of saline soil have provided much knowledge, which should be shared not only with scientists but also with end users such as landholders and local officers. To do this, the knowledge must be converted into simple, transferable environmental indicators. This approach will benefit Nanpi County and adjoining regions such as Huanghua and Haixing, where there are about 100,000 ha of saline soil (Liu and Tian 2000).

Selection of Key Indicators and Saline Soil Reclamation

Table 1 shows the key indicators selected for assessing soil salinity in Nanpi County based on the criteria developed by Walker and Reuter (1996) and on the theory and experience of saline soil reclamation (Mao and Liu 2000).

In Nanpi County, soil salinity and soil formation are controlled mainly by groundwater and water quality. The groundwater table itself is affected by

Table 1. Threshold guideline for soil salinity indicators in Nanpi County.

Indicator	Very good	Good	Fair	Poor	Very poor
Groundwater table (m)	4.5–6	3.5–4.5	2.5–3.5	1.5–2.5	< 1.5
Electrical conductivity in groundwater (dS/m)	<0.5	0.5–1	1–1.5	1.5–3	> 3
Soil colour	–	–	Grey brown	White	Grey black brown
Soil pH	7–7.5	7.5–8	8–8.5	8.5–9	> 9
Soil consistency	Loose	Soft	Firm	Very firm	Rigid

dS/m (deciSiemens per metre) = mS/cm (milliSiemens per centimetre)

climate, topography, irrigation and drainage, and is thus an important indicator of trends in water and salt balance. Based on a study at the Nanpi Eco-Agricultural Experimental Station (NPEES) of the Chinese Academy of Sciences, the groundwater table is declining by about 2–3 m each year (NPEES 1996, 1997, 1998, 1999). The reduction in the depth of the groundwater table helps to remove salt from the soil, but if it is too extensive it will result in seawater entering the watertable, increasing salinity.

Groundwater electrical conductivity (EC) is an indicator for irrigation water quality and soil alkalinisation during soil desalination. Soil colour is an important attribute for assessing soil quality, and in Nanpi County, soil colour can easily be used as an indicator of soil salinity. For example, saline soil containing chloride is grey, black or brown; saline soil containing sulfate is white. The pH value of soil can easily be measured with pH paper; the consistency of the soil can be tested by hand.

We used the indicators and methods of saline soil reclamation to construct a diagram for guiding saline soil reclamation (Fig. 1). The model indicates that controlling the groundwater table is the most important aspect of saline soil reclamation.

Rainwater, irrigation and the construction of

drainage systems are important in the adjustment of the groundwater table. Fertilisers and biological methods can also be used in soil reclamation (e.g. to supply N to raise the bioproductivity and grow salt-tolerant plants such as lucerne for fodder production).

Knowledge Transfer

In order to turn this knowledge into practice, we developed a knowledge transfer network and built several testing plots (Fig. 2). The network included NPEES, local government, a technical extension station, scientists, technicians and key users.

- *NPEES*. The station is a centre for knowledge creation and transfer, where scientists study indicators of salinity, assess trends in soil

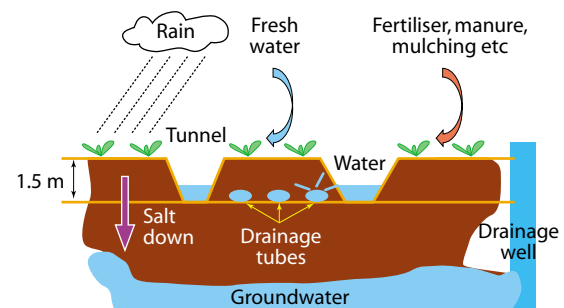


Figure 1. Diagram of saline soil reclamation in Nanpi County.

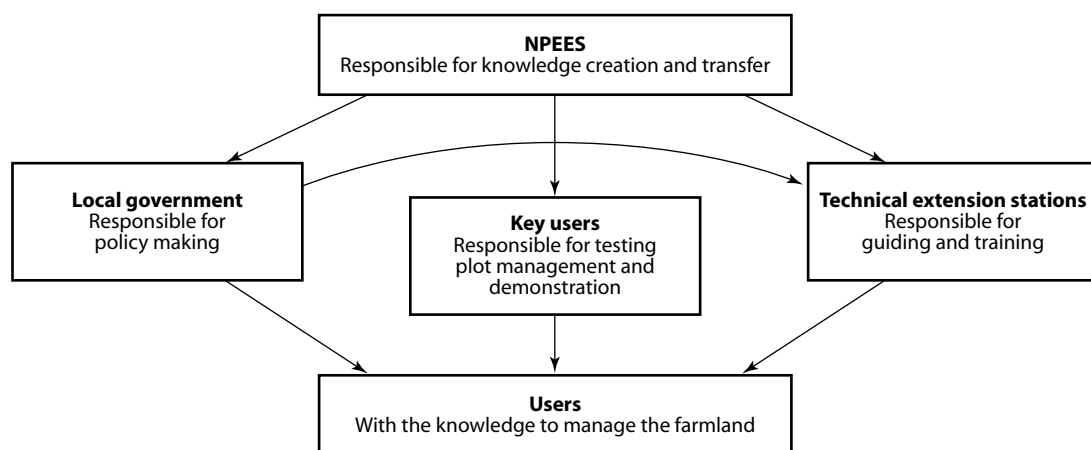


Figure 2. Knowledge transfer network in Nanpi County. NPEES is the Nanpi Eco-Agricultural Experimental Station.

salinity and monitor changes in the groundwater table. Twice a month, technicians from NPEES measure the groundwater table and electrical conductivity, and take water samples. In alternate months, starting in January, soil samples are also taken, to measure salt content and electrical conductivity. Scientists use the results to write proposals for local government and provide technical support for technical extension stations and users. NPEES has built five trial plots to demonstrate research results directly to end users. For example, in a trial plot close to the Dalangdian reservoir, vegetables are grown in greenhouses in winter. Groundwater is recharged mainly between November and January, when the introduction of fresh water improves the quality of the shallow groundwater and raises its level. Farmers can pump irrigation water and obtain a good income while improving groundwater use and controlling soil salinisation. Other trial plots demonstrate the irrigation of winter wheat and the use of cotton fields to grow pasture in winter.

- *Local government.* At least twice each year the local government in Nanpi County formulates policies based on technical reports and proposals from NPEES for managing regional agriculture. Local government asks extension stations and technical departments to use the research results, and it assists with knowledge transfer by providing some funding for publishing technical reports and holding meetings.
- *Technical extension stations.* Nanpi County has several technical extension stations, including an agricultural technical service and a soil and fertiliser technical station. Technicians at these stations are familiar with the needs and practices of the end users and are well placed to transfer knowledge to them. Therefore, NPEES asks the local government to send five technicians from different technical extension stations to NPEES, to act as a bridge between the institution and

end users during the growing seasons. Funds are available from local or higher levels of government for technology transfer.

- *Key users.* Key users are the landholders who use the indicators first and then demonstrate the results to other users. In China, landholders are often poorly educated; in order to be successful in implementing new practices, they need a good understanding of the changes they are being asked to make. Key users play an important role in knowledge transfer. Several well-educated users are taught how to use indicators to assess plot health and make rational decisions about plot management. Once these key users have obtained acceptable results, several site meetings are held on their plots, with other landholders invited to attend. Generally, these meetings are jointly organised by NPEES, local government and technical extension stations. In a meeting, a key user tells other landholders about the results he has obtained and how he has achieved them. Through this process, knowledge is transferred easily and quickly.
- *Users.* In a family unit in China, each landholder has only a small area of land: in Nanpi County this is about 0.8 ha/family. To see an effect of the indicators on catchment health, all the landholders in a village must be involved, which is difficult to achieve. Administrative measures and site meetings can be useful in organising landholders.

Results and Discussion

Over the past five years, we have made progress in using indicators to assess health in a saline environment. The area of saline soil in Nanpi County has continually decreased and there is no secondary salinity around Dalangdian reservoir. The mean income of landholders increased from 1100 yuan/person in 1996 to 2400 yuan/person in 2000 (US\$1 = 8.0 yuan). In certain areas where trial plots were located, such as Dalangdian, the net

income per hectare increased from 6000 yuan to 30,000 yuan. The groundwater table has been maintained at around 5 m and water quality is improving. The local government has formulated three policies for catchment health:

- building greenhouses around the Dalangdian reservoir;
- irrigation of winter wheat in spring; and
- using cotton fields in winter to grow pasture.

More than 3500 indicator report cards have been sent out. Eight site meetings have been held and more than 1000 landholders attended.

Although much has been achieved in assessing catchment health using indicators of salinity, much

remains to be done because this is a new technique for China. Indicator research on a regional scale with remote sense techniques and a computer-based transfer network is needed.

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