FINAL REPORT
OF THE RESEARCH ON BIOGEOCHEMICAL ROLE OF SANJIANG PLAIN FOR 2005

EXECUTOR: NORTHEAST INSTITUTE OF GEOGRAPHY AND AGRICULTURAL ECOLOGY, CHINESE ACADEMY OF SCIENCES(NEIGAE-CAS)

CUSTOMER: Research Institute for Humanity and Nature
Inter-University Research Institute Corporation
National Institutes for Humanities(RIHN)

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1 Main work in the fiscal year of 2005

1.1 Assist the Japanese copartner, Prof. Muneoki Yoh, for field survey in Raoli River and Bielahong River watershed in Sanjiang Plain; Assist the installing of plot monitoring instrument in the experimental field of Sanjiang Station(Ecological Experimental Station of Mire-wetlands in the Sanjiang Plain, Chinese Academy of Sciences) in June,2005.

Assist the Japanese copartner to carry out the field monitoring, sample collecting and measurement in Sanjiang Station in June, August and September, respectively.

1.2 Purchase and debugging material, instrument and equipment for collection and analyzing of sample, including Fe(II) analyzer, HORIBA U-10, portable refrigeratory (30 liters in volume) for preservation of samples used to measure the term of nitrogen, phosphorus, DOC and humic substances during the field work, Glass vial, plastic bottle, etc.

1.3 Collect the water samples of rivers, lakes, ground water and agricultural discharge water in all Sanjiang Plain in August and September respectively, including Amur River, Usuri River, Songhua River, Mudan River, Woken River, Naoli River, Yalu River and Nongjiang River. The location of samples is showed in Fig. 1 and Fig. 2. The basic information of sites is summarized in Table 1.

1.4 Analyzing items, pH value, EC, water temperature, salinity, turbidity, Fe(II), Fe(III) and bicarbonate, are determined in situ or near field within 12 hours. Other items, K, Na, Ca, Mg, total dissolved Fe, acid soluble Fe, total dissolved Mn, SiO_2, DOC, NH_4^+, NO_3^-, NO_2^-, PO_4^{3-}, etc., are measured in Lab of Northeast Institute of Geography and Agricultural Ecology, Chinese Academy of Sciences.

2 Sites and number of water samples

66 water samples were collected in August and September of 2005. The detailed information is listed in Fig.1, Fig.2 and table 1. The statistical number of different type water sample in two sampling is showed in Table 2.

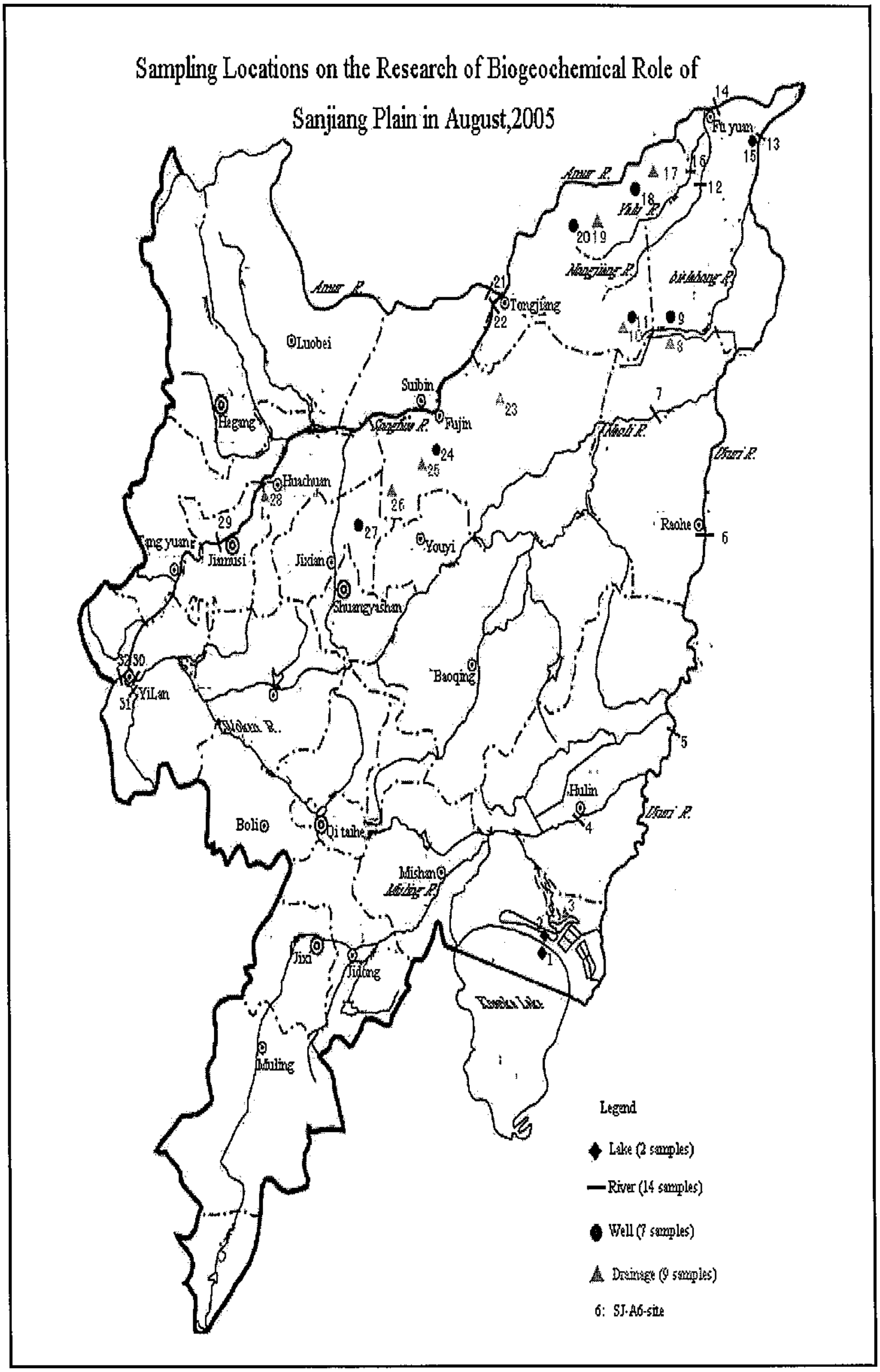

Fig.1 Location of sampling sites in August

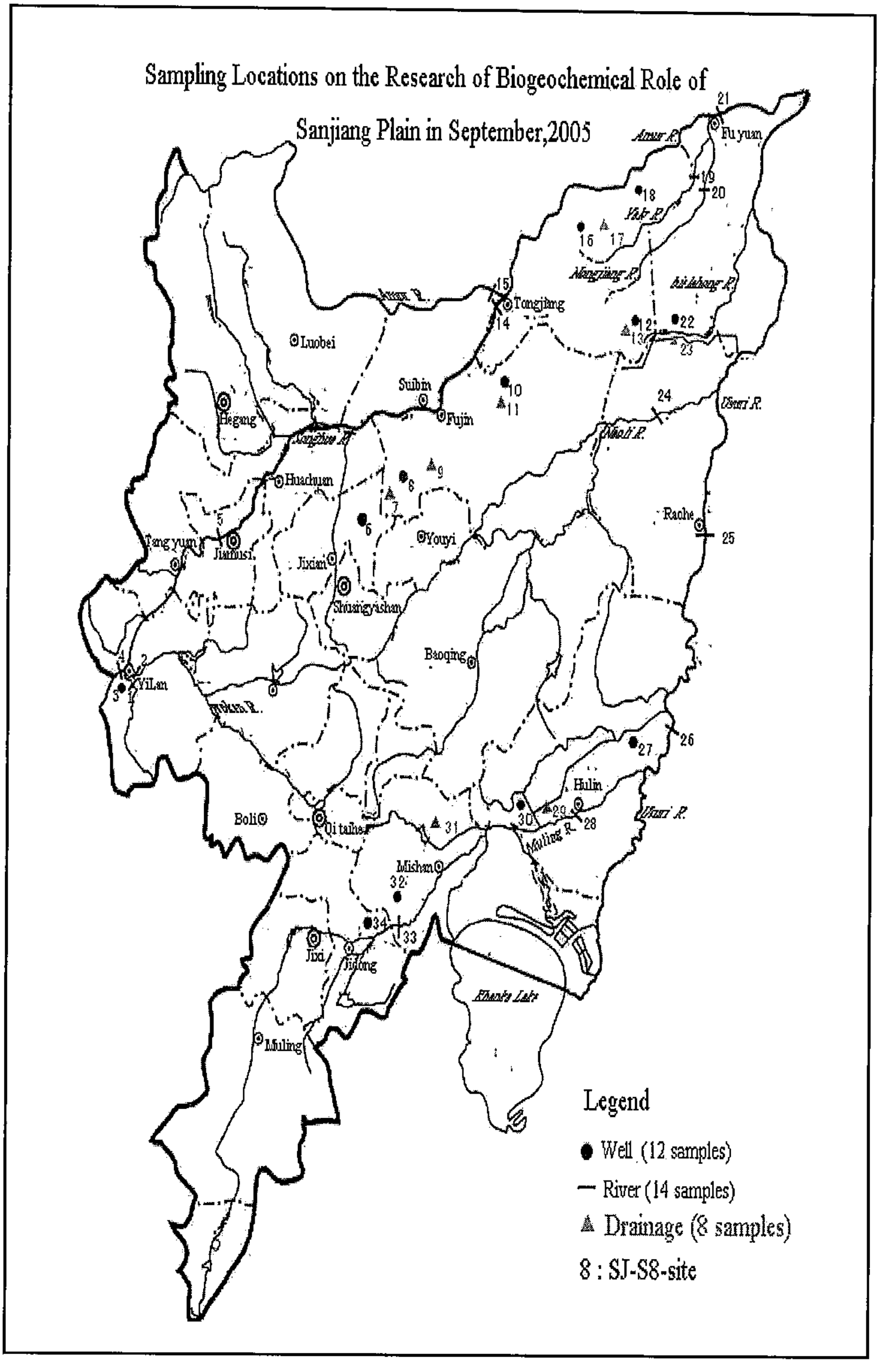

Fig. 2 Location of sampling sites in September

Table 1　Basic information of sampling sites

sample number	Sample types	River/Lake/channel/well	depth of well (m)	collection site	Sampling time	Coordinate
SJ-S1- YLM	River water	Mudan River		Yilan	2005-9-8	N 46°17.853′E129° 32.990′
SJ-S2- WKH	River water	Woken River		Yilan	2005-9-8	N 46°17.849′E129° 33.015′
SJ-S3- MD	Groundwater	Well for Drinking	15	Yilan	2005-9-8	N 46°18.101′E129° 29.542′
SJ-S4- BP	River water	Songhua River		Yilan	2005-9-8	N 46°18.711′E129° 30.002′
SJ-S5- JMS	River water	Songhua River		Jiamusi	2005-9-9	N 46°50.304′E129° 16.134′
SJ-S6- 291	Groundwater	Well for Drinking	30	291 Farm in Jixian	2005-9-9	N 46°50.637′E129° 16.954′
SJ-S7- HYP	Agricultural Drainage	Channel of Heiyupao		Fujin	2005-9-9	N 46°52.687′E131° 26.954′
SJ-S8- JMSGA	Groundwater	Well for Drinking	30	Jinshan town of Fujin	2005-9-9	N 46°53.357′E131° 28.711′
SJ-S9- CA	Agricultural Drainage	Channel		Chang'an town of Fujin	2005-9-9	N 46°08.296′E131° 53.879′
SJ-S10- XJ	Groundwater	Well for Drinking	9	Fujin	2005-9-9	N 47°23.586′E132° 23.670′
SJ-S11-ELS	Agricultural Drainage	Channel		Erlongshan town of Fujin	2005-9-9	N 47°23.574′E132° 28.652′
SJ-S12-HH_3	Groundwater	Well for Drinking	20	Honghe Farm	2005-9-9	N 47°34.641′E133° 34.843′
SJ-S13-LHP	Agricultural Drainage	Lianhuanpao Channel		Honghe Farm	2005-9-9	N 47°32.324′E133°30.329′
SJ-S14-TJS	River water	Songhua River		Tongjiang	2005-9-10	N 47°42.158′E132°31.310′
SJ-S15-TJH	River water	Amur River		Tongjiang	2005-9-10	N 47°42.870′E132°30.211′
SJ-S16-QDL_8	Groundwater	Well for Drinking	60	8 village,Qindeli Farm	2005-9-10	N 47°51.847′E102°56.775′
SJ-S17-QDL_{19}	Agricultural Drainage	Channel		19 village,Qindeli Farm	2005-9-10	N 47°56.398′E133°1.008′
SJ-S18-FM	Groundwater	Well for Drinking	10	Linjiang town of Tongjiang	2005-9-10	N 48°04.772′E133° 33.572′
SJ-S19-YLH	River water	Yalu River		Yinchuan town of Tongjiang	2005-9-10	N 48°04.779′E133°33.574′
SJ-S20-NJ	River water	Nongjiang River		Nongqiao town of Fuyuan	2005-9-10	N 48°11.788′E134°05.994′
SJ-S21-FYS	River water	Amur River		Fuyuan town of Fuyuan	2005-9-10	N48°22.616′E134°17.089′
SJ-S22-QF9	Groundwater	Well for Drinking	20	Qianfeng Farm	2005-9-10	N 47°35.719′E133°53.938′

SJ-S23-BLH	Agricultural Drainage	Channel of Bielahong River		Qianfeng Farm	2005-9-11	N 47°31.523′E133°52.908′
SJ-S24-NLH	River water	Naoli River		Xiaojiahe town of Raohe	2005-9-11	N 47°15.903′E138°45.630′
SJ-S25-RH	River water	Usuri River		Raohe town of Raohe	2005-9-11	N 46°43.054′E134°01.228′
SJ-S26-HT	River water	Usuri River		Hutou town of Hulin	2005-9-11	N 45°58.592′E133°40.113′
SJ-S27-FJC	Groundwater	Well for Drinking	12	Hutou town	2005-9-11	N 45°58.532′E133°40.112′
SJ-S28-MLH	River water	Muling River		Hulin	2005-9-11	N 45°44.403′E132°57.549′
SJ-S29-LS	Agricultural Drainage	Channel		Baodong town of Hulin	2005-9-12	N 45°43.200′E132°39.973′
SJ-S30-LRB	Groundwater	Well for Drinking	110	Hulin	2005-9-12	N 45°44.539′E132°19.452′
SJ-S31-FD	Agricultural Drainage	Channel		Feide town of Mishan	2005-9-12	N 45°37.180′E131°51.453′
SJ-S32-XH	Groundwater	Channel	20	Mishan	2005-9-12	N 45°34.898′E131°49.559′
SJ-S33-JDML	River water	Muling River		Mishan	2005-9-12	N 45°21.593′E131°30.466′
SJ-S34-SH	Groundwater	Well for Drinking	9	Jidong	2005-9-12	N 45°18.137′E131°09.404′
SJ-A_1-XK	Lake	Khanka Lake		Northeast Part, Khanka Lake	2005-8-6	45°17′22″N132°38′42″E
SJ-A_2-XXK	Lake	Small Khanka Lake		East Part, Small Khanka Lake	2005-8-6	45°17′15″N132°39′40″E
SJ-A_3-XKNC	Agricultural Drainage	Channel of Khanka Lake		Khanka Farm	2005-8-6	45°15′32″N132°50′35″E
SJ-A_4-ML	River Water	Muling River		Hulin	2005-8-7	45°44′23″N132°57′38″E
SJ-A_5-HT	River Water	Usuri River		Hutou Town, Hulin	2005-8-7	45°58′36″N133°40′00″E
SJ-A_6-RH	River Water	Usuri River		Raohe	2005-8-7	46°43′32″N134°01′13″E
SJ-A_7-XJH	River Water	Naoli River		Xiaojiahe Town, Raohe County	2005-8-7	47°15′54″N138°45′38″E
SJ-A_8-PG	Agricultural Drainage	Channel of Bielahong River		Qianfeng Farm	2005-8-7	47°31′31″N133°52′54″E
SJ-A_9-QF	Groundwater	Well in paddy field	40	Qianfeng Farm	2005-8-7	47°35′43″N133°53′55″E
SJ-A_{10}-HH	Agricultural Drainage	Channel of Bielahong River		Honghe Farm	2005-8-8	47°32′20″N 133° 30′55″E
SJ-A_{11}-SQ	Groundwater	Well in paddy field	28	Honghe Farm	2005-8-8	47°34′39″N 133°34′55″E
SJ-A_{12}-NJ	River Water	Nongjiang river		Nongqiao town of Fuyuan	2005-8-8	48°11′40″N 134°16′13″E
SJ-A_{13}-WS	River Water	Usuri River		Wusu town of fuyuan	2005-8-8	48°15′37″N 134°40′26″E

SJ-A_{14}-$FY_{3/6}$	River Water	Amur River		Fuyuan town of Fuyuan	2005-8-8	48°22′37″N 134°17′53″E
SJ-A_{14}-$FY_{2/6}$	River Water	Amur River		Fuyuan town of Fuyuan	2005-8-8	48°22′35″N 134°18′16″E
SJ-A_{14}-$FY_{1/6}$	River Water	Amur River		Fuyuan town of Fuyuan	2005-8-8	48°22′27″N 134°18′17″E
SJ-A_{15}-SS	Groundwater	Well for Drinking	100	Wusu town of fuyuan	2005-8-8	48°15′38″N 134°40′23″E
SJ-A_{16}-YL	River Water	Yalu River		Yinchuan town of Tongjiang	2005-8-9	48°11′48″N 134°06′00″E
SJ-A_{17}-LJ	Agricultural Drainage	Channel of Yalu River		Linjiang Town of Tongjiang	2005-8-9	48°10′01″N 133°53′26″E
SJ-A_{18}-FC	Groundwater	Well for Drinking	15	Fuchuan village,Linjiang town of Tongjiang	2005-8-9	48°03′07″N 133°29′00″E
SJ-A_{19}-QDL	Agricultural Drainage	Channel of Yalu River		Qindeli Farm	2005-8-9	47°56′24″N 133°10′00″E
SJ-A_{20}-Q_{20}	Groundwater	Well for Drinking(the ground water level is 3.9m).	9.5	20 village,Qindeli Farm	2005-8-9	47°56′39″N 133°06′54″E
SJ-A_{21}-TJH	River Water	Amur River		Tongjiang	2005-8-9	47°42′58″N 132°29′41″E
SJ-A_{22}-TJS	River Water	Songhua River		Tongjiang	2005-8-9	47°42′01″N 132°30′54″E
SJ-A_{23}-ELS	Agricultural Drainage	Channel		Erlongshan town of Fujin	2005-8-10	47°21′49″N 132°28′54″E
SJ-A_{24}-CA	Groundwater	Well in paddy field	30	Chang'an Town,Fujin	2005-8-10	47°06′28″N 131°50′33″E
SJ-A_{25}-FJ	Agricultural Drainage	Channel		Fujin	2005-8-10	47°03′56″N 131°47′17″E
SJ-A_{26}-HYP	Agricultural Drainage	Channel of Heiyupao		Fujin	2005-8-10	46°55′08″N 131°33′16″E
SJ-A_{27}-291	Groundwater	Well in paddy field	28	291 Farm of Jixian	2005-8-10	46°52′18″N 131°25′56″E
SJ-A_{28}-HC	Agricultural Drainage	Channel of Songhua River		Huachuan	2005-8-10	46°58′16″N 130°41′31″E
SJ-A_{29}-JMS	River Water	Songhua River		Jiamusi	2005-8-10	46°50′12″N 130°16′36″E
SJ-A_{30}-WKH	River Water	Woken River		Yilan	2005-8-11	46°19′35″N 129°34′52″E
SJ-A_{31}-MD	River Water	Mudan River		Yilan	2005-8-11	46°17′46″N 129°32′46″E
SJ-A_{32}-YLS	River Water	Songhua River		Yilan	2005-8-11	46°18′44″N 129°30′16″E

Table 2 Sample number in different type

item	Surface water	Ground water	Agricultural drainage water	Sub total
August	16	7	9	32
September	14	12	8	34
total	30	19	17	66

3 Methods of sample pre-processing and measurement

3.1 Methods of sample pre-processing

After collected, water samples should be treated for the processes of filtration, adding acid, low temperature conserve, etc.. The detailed approaches for all items are illustrated in Fig. 3.

3.2 Determination of Fe^{2+} using ferrozine absorption spectrophotometer method（Eswara et al,1976;James C,et al,1984; Wang JQ,et al,1997）

3.2.1 Principle

Fe(Ⅱ) can form a purple complex with ferrozine mono-sodium salt at the condition of pH 4.6. There is a good relationship between Fe(Ⅱ) concentrations and the absorptive degree of the solution. So, Fe(Ⅱ) can be analyzed using absorption spectrophotometer method. The maximum absorptive wavelength is 562nm, in which the molar absorption coefficient is 286000.

Hydroxylamine, a kind of reducing agent, can reduce Fe(Ⅲ) to Fe(Ⅱ). So, the Fe(Ⅲ) concentration in the sample may be gained by subtracting Fe(Ⅱ) concentration from total iron(Fe^{2+}+ Fe^{3+}).

3.2.2 Procedure

1) **Fe(Ⅱ) analysis**

- Preheating and calibration the instrument;
- Add 2mL volume solution A (ferrozine mono-sodium solution) into a 10mL volumetric flask;

- Add appropriate volume of water sample (See Table 3) ;

Table 3 The reference volume of water sample to add into the 10mL volumetric flask

Estimation concentration range of Fe^{2+} in the sample	Sample volume (V_1)
>10 mg/L	<0.5 mL
1~10 mg/L	5~0.5 mL
<1 mg/L	8 mL,namely add water sample to the scale of the flask

- Wait for unveiling color;
- Measure the water sample.

2) **Total iron (Fe^{2+}+Fe^{3+}) analysis (Wang J Q, et al, 1998)**

- Add solution B (hydroxylamine solution) and appropriate volume of water sample into a 10mL volumetric he flask;
- Add buffer solution with pH in 4.6 to the full graduation/scale on the flask;
- Shake the mixed solution up and placed 3 minutes for reduction of Fe^{3+} to Fe^{2+} thoroughly;
- Measure the concentration of total Fe^{2+} in the sample. After the solution is imbibed by the apparatus, a reading C_1 should be showed on the display of apparatus.

3.2.3 Calculation

The concentration of Fe^{2+} is estimated from the following formula:

$$X_1 \ (ppm) = C_1(ppm) * V(ml)/V_1(ml)$$

Where, X_1 is the concentration of Fe^{2+} in the sample;

C_1 is the reading for the sample on the display of the apparatus;

V_1 is the sample volume we add into the volumetric flask;

V is 10mL in this method.

If the total iron concentration, namely Fe^{3+} plus Fe^{2+}, is determined, Fe^{3+} concentration can be got easily by computing.

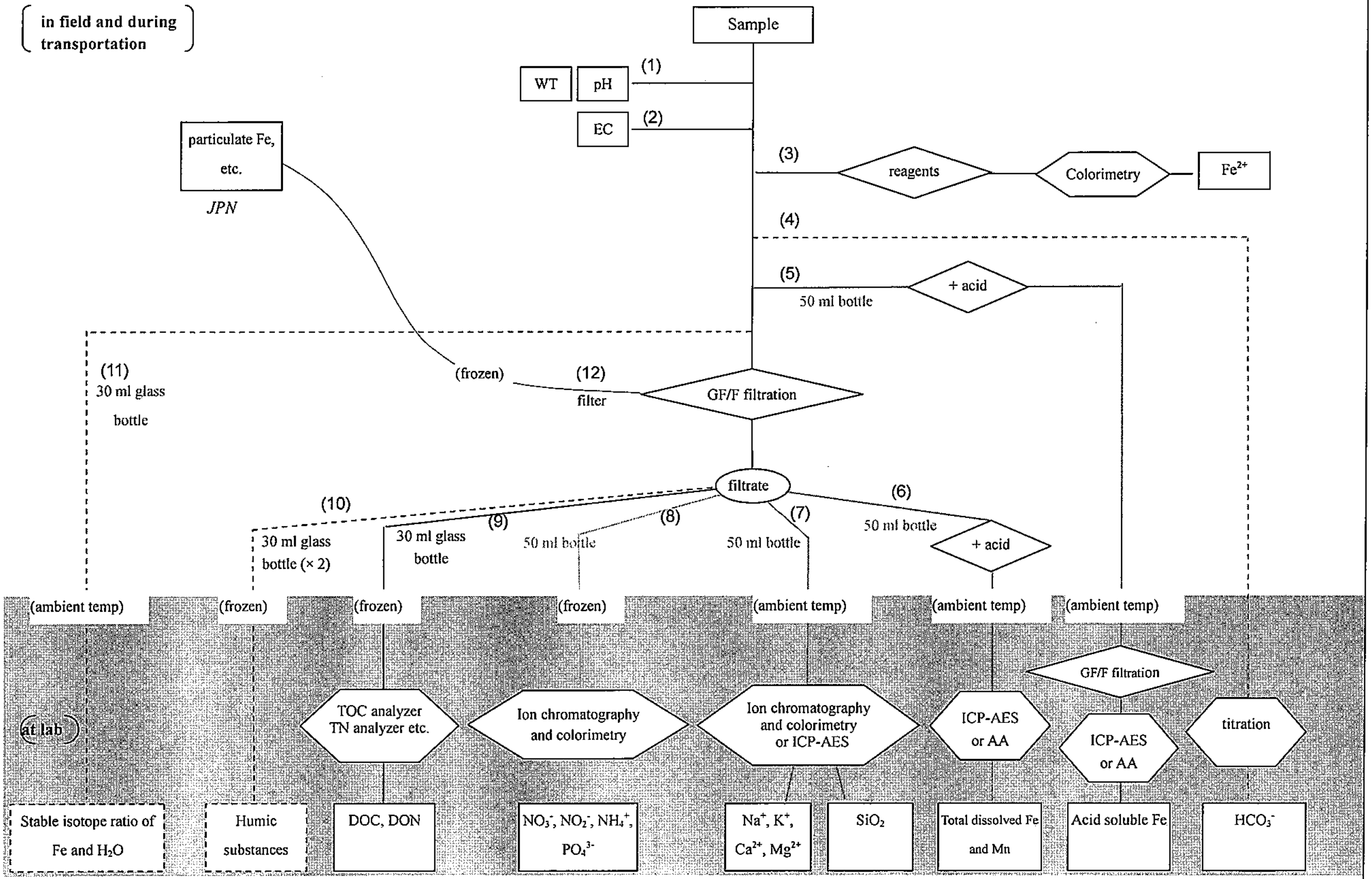

Fig. 3 Chart of flow and methods for water samples treatments

3.3 Determination of other items

The determination methods of other items except Fe^{2+} are listed in Table 4.

Table 4 Measurement method and analyzer

Elements	Method	Analyzer	Remark
NH_4^+,NO_3^-,NO_2^-,PO_4^{3-}	Colorimetry	SKALAR-SAN++ continuous flow analyzer (Holland SKALAR Co. Ltd.)	In lab
K, Na, Ca, Mg, Total dissolved Fe, acid soluble Fe, Total dissolved Mn	AAS	GBC 906 atom absorption spectrophotometer (Australia GBC Co. Ltd.)	In lab
SiO_2	Colorimetry		In lab
DOC	TOC-V_{CPH}	TOC analyzer(Shimadzu Co. Ltd.)	In lab
Fe^{2+} and Fe^{3+}	Ferrozine mono-sodium salt absorption spectrophotometer method	RPA-100 Fe^{2+} analyzer (Jianghuan analyse instrument Co. Ltd.)	Field*
HCO_3^-	titration		Field*
pH, EC, WT, SAL (Salinity),TURB(turbidity)	electrode method	HORIBA U-10 (Japan HORIBA Co. Ltd.)	In situ

* measured within 12 hours.

4 The results of measurement and analysis

The measurement results of iron (Total dissolved iron, acid soluble iron, Fe^{2+}, Fe^{3+}), Manganese(Total dissolved Mn), DOC, nitrogen, phosphorus, base cation and anion, water temperature, pH, EC, salinity, turbidity are listed in Table 5, Table 6 and Table 7, respectively.

Table 5 the concentrations of Fe, Mn and DOC

sample	Total dissolved Fe	Total dissolved Mn	acid soluble Fe	Fe^{2+}	Fe^{3+}	DOC
SJ-S1- YLM	1.347	nd	1.504	0.18	0.08	6.441
SJ-S2- WKH	0.205	0.017	4.659	0.63	0.36	4.100
SJ-S3- MD	7.617	0.850	8.749	7.50	0.50	3.366
SJ-S4- BP1	0.362	nd	1.415	0.23	0.14	4.006
SJ-S5- JMS	0.345	0.044	1.920	0.26	0.19	5.358
SJ-S6- 291	3.095	0.313	6.725	3.00	1.13	0.756
SJ-S7- HYP	nd	nd	nd	0.04	0.03	7.172
SJ-S8- JMSGA	5.749	0.783	17.107	1.20	0.82	0.931
SJ-S9- CA	nd	nd	nd	0.05	0.08	9.407
SJ-S10- XJ	2.080	nd	2.544	0.44	0.14	7.933
SJ-S11-ELS	49.992	10.271	88.904	41.00	3.00	180.700
SJ-S12-HH_3	9.460	0.357	10.253	7.50	1.50	0.059
SJ-S13-LHP	0.284	nd	0.660	0.05	0.05	7.541
SJ-S14-TJS	0.080	nd	0.251	0.03	0.01	9.959
SJ-S15-TJH	0.365	nd	1.354	0.16	0.04	5.464
SJ-S16-QDL_8	nd	nd	nd	0.01	0.01	0.520
SJ-S17-QDL_{19}	0.803	nd	1.491	0.06	0.10	3.674
SJ-S18-FM	8.460	0.453	9.947	5.00	0.10	0.269
SJ-S19-YLH	6.397	nd	7.953	0.09	0.54	21.330
SJ-S20-NJ	2.191	nd	2.388	0.05	0.13	9.548
SJ-S21-FYS_0	0.404	nd	0.980	0.15	0.10	4.468
SJ-S22-QF9	7.783	0.374	8.078	4.00	0.33	0.208
SJ-S23-BLH	0.853	nd	0.964	0.10	0.08	7.041
SJ-S24-NLH	6.033	0.217	6.340	0.05	0.18	14.700
SJ-S25-RH	0.428	nd	0.855	0.03	0.03	4.668
SJ-S26-HT	0.403	nd	0.728	0.05	0.05	6.443
SJ-S27-FJC	40.953	4.341	44.050	20.50	0.50	0.032
SJ-S28-MLH	0.175	0.012	1.944	0.16	0.15	5.796
SJ-S29-LS	0.085	nd	0.493	0.05	0.04	4.102
SJ-S30-LRB	nd	nd	nd	0.02	0.50	0.038
SJ-S31-FD	0.153	nd	3.078	0.20	0.08	8.272
SJ-S32-XH	nd	nd	nd	0.10	0.27	0.230
SJ-S33-JDML	nd	nd	0.049	0.03	0.01	13.280

SJ-S34-SH	nd	nd	nd	0.01	0.20	0.276
SJ-A_1-XK	0.209	nd	0.549	0.15	0.11	2.753
SJ-A_2-XXK	nd	nd	nd	0.01	0.05	4.475
SJ-A_3-XKNC	nd	0.026	nd	0.10	0.08	3.699
SJ-A_4-ML	0.078	nd	2.801	0.80	0.40	6.019
SJ-A_5-HT	0.170	nd	0.621	0.10	0.08	6.085
SJ-A_6-RH	0.324	nd	0.785	0.10	0.04	4.891
SJ-A_7-XJH	0.524	nd	0.583	0.13	0.09	7.264
SJ-A_8-PG	0.606	nd	1.017	0.10	0.08	10.700
SJ-A_9-QF	10.815	0.265	12.061	10.20	0.40	42.370
SJ-A_{10}-HH	0.769	nd	0.948	0.08	0.25	8.323
SJ-A_{11}-SQ	2.262	0.011	3.147	1.05	4.00	1.444
SJ-A_{12}-NJ	1.537	nd	1.835	0.05	0.18	13.750
SJ-A_{13}-WS	0.435	nd	0.616	0.20	0.18	5.617
SJ-A_{14}-FY	0.266	nd	0.379	0.28	0.15	9.680
SJ-A_{15}-SS	8.880	0.667	10.452	7.50	0.50	15.290
SJ-A_{16}-YL	1.106	0.077	1.946	0.05	0.08	5.635
SJ-A_{17}-LJ	5.412	0.042	6.408	0.18	0.13	11.010
SJ-A_{18}-FC	8.344	1.491	10.395	8.00	0.50	0.863
SJ-A_{19}-QDL	8.289	0.167	9.905	0.13	0.30	21.230
SJ-A_{20}-Q_{20}	4.575	0.764	5.874	3.50	1.50	0.992
SJ-A_{21}-TJH	0.330	nd	1.051	0.05	0.95	8.153
SJ-A_{22}-TJS	0.684	nd	0.823	0.19	0.17	6.413
SJ-A_{23}-ELS	3.044	nd	3.289	0.50	0.08	5.688
SJ-A_{24}-CA	5.158	0.274	10.425	5.00	0.20	3.723
SJ-A_{25}-FJ	0.177	nd	0.286	0.20	0.25	6.698
SJ-A_{26}-HYP	nd	nd	nd	0.08	0.01	4.359
SJ-A_{27}-291	2.142	0.796	6.119	0.13	0.13	1.454
SJ-A_{28}-HC	0.527	nd	0.547	0.48	0.03	3.534
SJ-A_{29}-JMS	0.731	nd	1.115	0.25	0.11	4.821
SJ-A_{30}-WKH	0.252	0.012	1.252	0.18	0.16	3.926
SJ-A_{31}-MD	0.937	nd	1.228	0.31	0.01	4.574
SJ-A_{32}-YLS	0.173	nd	0.558	0.28	0.03	64.170

"nd" means the content measured is lower than the determining limit of the instrument.

Table 6 Concentrations of nitrogen, phosphorus ,silicon and pH etc.

Sample	WT ℃	SAL %	pH*	EC ms/cm	TURB NTU	NH_4^+-N mg/L	NO_3^--N mg/L	NO_2^--N μg/L	PO_4^{3-} mg/L	SiO_2 mg/L
SJ-S1-YLM	22.2	0.00	7.43	0.120	153	0.043	0.995	26.094	0.016	25.91
SJ-S2-WKH	23.2	0.01	7.38	0.333	999	0.027	1.610	72.828	0.027	13.78
SJ-S3-MD	7.2	0.01	6.94	0.359	33	1.366	0.053	16.547	<0.005	42.04
SJ-S4-BP3	21.6	0.01	7.54	0.280	10	0.236	1.331	26.120	0.016	16.06
SJ-S5-JMS	20.7	0.00	7.32	0.205	210	0.021	0.977	13.407	0.005	13.07
SJ-S6-291	6.5	0.01	7.28	0.348	42	0.335	0.006	<0.50	0.015	34.91
SJ-S7-HYP	21.7	0.01	7.14	0.419	10	0.029	0.593	157.502	<0.005	0.36
SJ-S8-JMSGA	7.1	0.02	7.59	0.515	10	0.209	0.011	3.333	<0.005	20.20
SJ-S9-CA	22.7	0.00	7.13	0.242	10	<0.005	<0.005	<0.50	<0.005	1.65
SJ-S10-ELS	9.5	0.01	6.96	0.265	85	0.038	0.632	25.578	0.037	7.79
SJ-S11-XJ	23.3	0.06	7.01	1.500	187	0.131	<0.005	<0.50	<0.005	25.20
SJ-S12-HH_3	8.3	0.01	6.41	0.320	350	1.362	<0.005	<0.50	<0.005	23.49
SJ-S13-LHP	23.5	0.00	7.29	0.142	10	0.022	<0.005	<0.50	0.016	5.50
SJ-S14-TJS	20.6	0.00	7.31	0.001	94	0.019	<0.005	<0.50	<0.005	14.21
SJ-S15-TJH	18.5	0.00	7.61	0.075	744	0.021	1.002	27.000	<0.005	14.78
SJ-S16-QDL_8	6.7	0.02	7.06	0.513	70	<0.005	9.932	18.964	<0.005	24.63
SJ-S17-QDL_{19}	17.3	0.00	7.37	0.204	10	0.790	1.070	140.923	0.068	11.07
SJ-S18-FM	10.2	0.01	7.33	0.272	10	0.319	0.255	7.065	<0.005	29.34
SJ-S19-YLH	18.9	0.00	6.64	0.121	10	0.018	0.132	13.476	0.419	0.35
SJ-S20-NJ	20.2	0.00	6.78	0.078	10	0.014	0.169	8.404	0.026	0.32
SJ-S21-FYS_0	20.3	0.00	6.94	0.171	10	0.029	0.978	16.201	0.035	12.35
SJ-S22-QF9	9.8	0.01	6.72	0.420	22	0.454	1.179	22.674	0.013	31.34
SJ-S23-BLH	19.7	0.00	7.64	0.129	10	0.029	0.185	22.262	0.020	5.36
SJ-S24-NLH	18.5	0.00	6.50	0.155	10	0.015	0.029	22.124	0.046	2.36
SJ-S25-RH	20.3	0.00	7.25	0.101	10	0.029	0.034	14.408	0.015	14.78
SJ-S26-HT	22.0	0.00	7.38	0.144	10	0.062	3.484	36.637	0.026	12.50
SJ-S27-FJC	9.5	0.01	7.37	0.267	227	0.345	0.090	<0.50	0.009	29.06
SJ-S28-MLH	23.2	0.01	7.27	0.262	71	0.170	1.219	24.639	0.039	18.35
SJ-S29-LS	20.6	0.00	7.22	0.159	10	0.070	0.114	<0.50	0.014	14.78
SJ-S30-LRB	6.3	0.01	7.67	0.452	10	0.003	0.942	17.730	<0.005	20.78
SJ-S31-FD	20.1	0.01	7.25	0.260	5	1.105	1.892	61.362	0.009	15.07
SJ-S32-XH	8.2	0.01	7.38	0.274	186	0.039	3.167	2.909	0.028	35.48
SJ-S33-JDML	19.9	0.01	7.19	0.263	10	<0.005	0.194	<0.50	0.003	13.64
SJ-S34-SH	9.1	0.07	7.35	0.171	10	0.392	20.104	6.464	0.021	26.77

SJ-A_1-XK	24.9	0.00	0.165	64	0.005	<0.005	3.860	0.049	17.21
SJ-A_2-XXK	25.8	0.00	0.188	1	<0.005	<0.005	0.262	0.011	1.65
SJ-A_3-XKNC	25.6	0.00	0.243	41	<0.005	<0.005	2.590	0.005	15.21
SJ-A_4-ML	25.0	0.00	0.161	999	0.051	1.093	15.502	0.047	23.35
SJ-A_5-HT	25.0	0.00	0.112	74	0.005	0.400	21.119	0.022	20.35
SJ-A_6-RH	25.2	0.00	0.066	88	0.015	0.148	7.096	0.012	18.35
SJ-A_7-XJH	26.5	0.00	0.150	59	<0.005	0.137	7.819	0.053	14.07
SJ-A_8-PG	25.1	0.00	0.146	17	0.154	<0.005	2.583	0.050	13.78
SJ-A_9-QF	8.5	0.01	0.297	3	0.446	0.003	14.696	0.398	49.61
SJ-A_{10}-HH	25.1	0.00	0.145	21	<0.005	<.005	2.396	0.046	13.07
SJ-A_{11}-SQ	7.3	0.01	0.281	291	1.343	0.012	1.123	0.782	44.04
SJ-A_{12}-NJ	25.4	0.00	0.820	2	0.006	0.008	2.110	0.055	15.92
SJ-A_{13}-WS	25.1	0.00	0.116	169	0.005	0.656	8.155	0.033	21.49
SJ-A_{14}-FY	24.7	0.00	0.123	212	<0.005	0.810	12.552	0.039	20.63
SJ-A_{15}-SS	7.6	0.00	0.232	220	1.423	0.058	26.477	0.011	41.19
SJ-A_{16}-YL	23.9	0.00	0.141	25	0.005	0.012	1.579	0.008	22.92
SJ-A_{17}-LJ	23.1	0.00	0.062	62	0.097	0.081	52.573	0.068	5.79
SJ-A_{18}-FC	8.3	0.00	1.121	101	0.155	0.037	5.685	0.011	33.48
SJ-A_{19}-QDL	25.4	0.00	0.158	51	<0.005	0.637	81.738	0.256	30.20
SJ-A_{20}-Q_{20}	8.2	0.00	0.121	281	0.190	0.022	0.806	0.447	34.62
SJ-A_{21}-TJH	24.8	0.00	0.072	13	<0.005	0.148	11.458	0.015	18.64
SJ-A_{22}-TJS	25.5	0.00	0.118	177	<0.005	0.810	19.018	0.040	19.63
SJ-A_{23}-ELS	25.4	0.00	0.250	234	0.321	2.050	303.980	0.317	0.94
SJ-A_{24}-CA	7.7	0.01	0.293	82	0.047	0.106	1.693	0.005	34.48
SJ-A_{25}-FJ	26.0	0.01	0.189	10	<0.005	0.018	1.016	0.033	10.50
SJ-A_{26}-HYP	25.8	0.01	0.373	10	<0.005	0.016	1.036	0.101	4.79
SJ-A_{27}-291	7.9	0.01	0.421	206	0.361	0.008	<0.50	0.005	30.77
SJ-A_{28}-HC	25.5	0.00	0.109	93	<0.005	0.011	8.371	0.029	11.36
SJ-A_{29}-JMS	24.8	0.00	0.147	127	<0.005	0.901	9.993	0.050	19.21
SJ-A_{30}-WKH	24.7	0.01	0.221	169	0.005	0.687	27.165	0.059	20.06
SJ-A_{31}-MD	24.3	0.00	0.277	414	0.013	0.938	13.333	0.037	19.63
SJ-A_{32}-YLS	24.9	0.01	0.185	295	0.032	1.156	3.048	0.047	22.35

* pH values in August had obvious error due to the electrode failure.

Table 7 Analyzing results of basic cation and anion in 2005 in mg/L

Sample No	K	Na	Ca	Mg	HCO_3^-	Cl^-	SO_4^{2-}
SJ-S1- YLM	0.888	7.275	15.487	3.455	65.88	5.97	3.85
SJ-S2- WKH	2.376	31.136	22.592	9.820	161.04	19.51	2.28
SJ-S3- MD	0.731	15.557	44.266	10.857	234.24	1.10	1.03
SJ-S4- BP1	1.736	23.976	24.687	6.178	109.80	31.86	2.44
SJ-S5- JMS	1.312	18.116	17.551	5.433	102.48	11.87	2.96
SJ-S6- 291	0.735	22.683	61.670	13.409	256.20	35.70	0.18
SJ-S7- HYP	6.390	39.537	28.209	18.474	285.48	3.00	0.34
SJ-S8-JMSGA	0.706	23.540	56.913	17.006	226.92	55.54	0.47
SJ-S9- CA	2.351	13.697	27.917	8.615	161.04	3.81	0.53
SJ-S10- XJ	6.424	18.271	28.530	8.357	124.44	34.81	0.31
SJ-S11-ELS	0.651	24.913	62.443	19.518	256.56	53.82	5.21
SJ-S12-HH_3	1.207	22.012	31.601	11.389	220.20	1.46	0.09
SJ-S13-LHP	3.146	11.290	34.266	6.246	95.16	43.73	0.17
SJ-S14-TJS	0.050	4.081	17.089	3.156	73.20	1.19	2.83
SJ-S15-TJH	1.361	16.752	36.620	5.723	146.40	20.51	0.66
SJ-S16-QDL_8	0.745	19.997	54.690	11.463	240.12	0.23	0.06
SJ-S17-QDL_{19}	4.483	13.327	20.170	7.007	139.08	1.89	0.14
SJ-S18-FM	0.773	16.205	15.061	6.840	117.12	3.24	1.57
SJ-S19-YLH	2.397	12.328	19.162	5.754	124.44	1.58	0.06
SJ-S20-NJ	0.779	6.247	20.264	5.956	109.80	1.32	0.88
SJ-S21-FYS_0	0.766	12.827	22.991	5.106	121.76	1.15	2.36
SJ-S22-QF9	0.766	19.650	42.631	11.582	235.12	1.62	0.18
SJ-S23-BLH	1.113	10.529	7.697	5.963	95.16	8.37	0.54
SJ-S24-NLH	1.239	10.393	28.279	7.388	124.44	15.34	1.42
SJ-S25-RH	0.765	7.043	7.877	5.965	65.88	3.99	0.83
SJ-S26-HT	0.772	11.503	63.152	5.183	87.84	85.28	0.39
SJ-S27-FJC	0.765	6.713	36.715	6.321	153.72	5.17	0.81
SJ-S28-MLH	1.024	19.383	36.136	9.577	146.40	34.48	0.65
SJ-S29-LS	0.765	8.456	22.751	7.831	139.08	7.75	4.72
SJ-S30-LRB	0.766	18.984	43.145	15.107	247.08	3.41	1.39
SJ-S31-FD	1.498	17.449	28.444	7.281	168.36	1.42	1.93
SJ-S32-XH	0.766	26.615	28.853	8.657	183.00	0.41	4.56
SJ-S33-JDML	0.767	23.474	28.833	8.413	175.68	3.81	8.23

SJ-S34-SH	0.963	31.577	51.954	20.298	173.20	42.27	10.65
SJ-A_1-XK	1.046	11.319	12.513	5.791	91.50	18.46	1.14
SJ-A_2-XXK	0.765	19.270	8.967	6.671	92.23	23.08	0.14
SJ-A_3-XKNC	0.766	20.680	17.349	8.628	136.64	22.37	1.12
SJ-A_4-ML	0.800	11.540	13.018	6.150	73.20	17.75	1.76
SJ-A_5-HT	0.763	8.146	9.201	4.364	58.56	12.42	0.41
SJ-A_6-RH	0.765	4.668	5.223	2.808	36.60	9.94	0.32
SJ-A_7-XJH	0.764	10.418	12.120	6.670	51.24	14.20	0.24
SJ-A_8-PG	0.819	10.247	11.241	6.913	51.24	10.65	<0.05
SJ-A_9-QF	0.766	15.293	22.353	11.920	146.40	12.42	<0.05
SJ-A_{10}-HH	0.960	11.718	9.884	6.296	58.56	10.65	<0.05
SJ-A_{11}-SQ	0.764	22.576	20.475	10.474	162.96	8.88	<0.05
SJ-A_{12}-NJ	0.764	6.315	10.181	4.396	58.56	10.65	0.47
SJ-A_{13}-WS	0.765	7.749	11.334	3.689	58.56	12.42	<0.05
SJ-A_{14}-FY	0.766	9.373	10.880	4.081	65.88	14.20	2.20
SJ-A_{15}-SS	0.765	11.851	17.225	7.902	121.68	10.65	6.97
SJ-A_{16}-YL	0.766	8.832	12.375	6.769	94.19	12.42	<0.05
SJ-A_{17}-LJ	0.976	4.466	3.458	1.763	29.28	10.65	<0.05
SJ-A_{18}-FC	0.765	18.681	17.384	4.753	76.13	40.82	1.16
SJ-A_{19}-QDL	0.891	9.098	13.086	7.906	87.84	14.20	<0.05
SJ-A_{20}-Q_{20}	0.766	7.990	12.134	5.741	84.91	8.88	<0.05
SJ-A_{21}-TJH	0.765	4.863	7.329	3.144	43.92	9.94	0.70
SJ-A_{22}-TJS	0.767	10.753	11.464	4.420	68.81	13.49	2.10
SJ-A_{23}-ELS	8.011	16.982	18.097	5.626	109.80	28.40	4.90
SJ-A_{24}-CA	0.766	22.552	23.061	6.400	162.96	12.42	0.32
SJ-A_{25}-FJ	0.766	12.392	14.800	7.918	116.44	14.20	0.41
SJ-A_{26}-HYP	3.956	34.782	30.449	14.042	260.84	17.75	0.26
SJ-A_{27}-291	0.766	25.182	39.625	15.278	264.76	12.42	<0.05
SJ-A_{28}-HC	0.764	8.724	12.055	3.611	73.20	14.20	1.22
SJ-A_{29}-JMS	0.764	13.989	12.348	4.801	87.84	15.98	2.31
SJ-A_{30}-WKH	1.337	17.979	17.387	7.306	126.78	17.75	2.44
SJ-A_{31}-MD	0.766	7.251	8.567	3.164	53.24	12.42	2.37
SJ-A_{32}-YLS	0.769	15.430	13.691	4.890	94.91	17.75	1.70

S in middle of sample number means the sample collected in September and A means in August, 2005.

4.1 **Elimination of abnormal value**

Because of insurmountability factors in the processes of sample collecting, filtration and analyzing, it is hard to insure all samples and processes unstained though all processes were operated according to strict programs.

The sample SJ-S11-ELS was collected from an agricultural drainage in September 2005 in Erlongshan Town, Fujin County. Total dissolved Fe, acid soluble Fe, Total dissolved Mn, Fe(II), Fe(III) and DOC concentrations(Table 5) were 49.992 , 88.904 , 10.271, 41.00 , 3.00 , 180.700mg/L,respectively. They are very highest among the same item and the data of other items are not too high. Comparison with the results of nearby samples of agricultural drainage, SJ-S9-CA, SJ-A23-ELS and SJ-A25-CA in August and September(Table 5), no reasonable reason explains these results. So, the data of the sample SJ-S11-ELS is eliminated as abnormal data.

4.2 Iron and manganese

4.2.1 The concentration level of iron and manganese in surface water

The mean concentration of total dissolved iron in river(Table 5 and Table 8) is 0.89mg/L (0.03- 6.397 mg/L), and acid soluble iron is 1.62mg/L(0.03-7.953mg/L), most of which are more than the limited concentrations of Fe (0.3mg/L) in drinking water from surface water source in Environmental Quality Standard for Surface Water in China(GB3838-2002). The concentrations are also higher than those in Amazon (0.034 mg/L), Yukon River (0.05mg/L), mean content of nature surface water of world (0.50mg/L, 0.01-1.40mg/L in range), Mississippi River (5μg/L), Rhine (3.5 μg/L)， Danube (74μg/L), Yangtze River (8.24 μg/L), Pearl (0.245mg/L) and Xiangjiang River (0.12mg/L)(Liao Z J,1992; Sheng Z S,et al,1998)。But the iron concentration is less than those(6.5-50mg/L) in rivers running through swamped areas in Amur basin(Schesterkina and Ivanov, 1981).

Comparison with the concentrations in other reservoirs and rivers in China, the concentrations in river water in Sanjiang Plain are also higher than most of those (0.04-1.30mg/L) in rivers and reservoirs in the Second Songhua River basin(Xu X L,

Table 8 Fe concentrations(mg/L) in river, ground water and agricultural drainage in Sanjiang Plain

elements	month	River water		Ground water		Agricultural drainage	
		mean	range	mean	range	mean	range
total dissolved Fe	Sep.	1. 34	0. 08-6. 397	7. 11	0. 03-40. 95	0. 32	0. 03-0. 85
	Aug.	0. 49	0. 03-1. 537	6. 03	2. 14-10. 82	2. 10	0. 03-8. 29
	Annual	0. 89	0. 03-6. 397	6. 71	0. 03-40. 95	1. 32	0. 03-8. 29
acid soluble Fe	Sep.	2. 31	0. 05-7. 953	8. 96	0. 03-44. 05	0. 96	0. 03-3. 08
	Aug.	1. 01	0. 03-2. 801	8. 35	3. 15-12. 06	2. 50	0. 03-9. 91
	Annual	1. 62	0. 03-7. 952	8. 74	0. 03-44. 05	1. 83	0. 03-9. 91
Fe^{2+}	Sep.	0. 15	0. 03-0. 63	4. 11	0. 01-20. 5	0. 08	0. 04-0. 20
	Aug.	0. 20	0. 01-0. 80	5. 05	0. 13-10. 2	0. 21	0. 08-0. 50
	Annual	0. 17	0. 01-0. 80	4. 46	0. 01-20. 5	0. 15	0. 04-0. 50
Fe^{3+}	Sep.	0. 14	0. 01-0. 54	0. 50	0. 01-1. 50	0. 07	0. 03-0. 10
	Aug.	0. 17	0. 01-0. 95	1. 03	0. 13-1. 50	0. 13	0. 01-0. 30
	Annual	0. 16	0. 01-0. 95	0. 70	0. 01-1. 50	0. 10	0. 01-0. 30
Mn	Sep.	0. 028	0. 010-0. 217	0. 627	0. 010-4. 341	0. 010	0. 010-0. 010
	Aug.	0. 014	0. 010-0. 077	0. 610	0. 011-1. 491	0. 033	0. 010-0. 167
	Annual	0. 021	0. 010-0. 217	0. 620	0. 010-4. 341	0. 023	0. 010-0. 167
DOC	Sep.	8. 25	4. 10-14. 70	1. 22	0. 03-7. 93	6. 74	3. 674-9. 41
	Aug.	9. 89	2. 753-64. 17	9. 45	0. 86-42. 37	8. 36	3. 534-21. 23
	Annual	9. 13	2. 753-64. 17	4. 25	0. 03-42. 37	7. 65	3. 534-21. 23

2000) and those (0.83mg/L) in Hangjiahu Plain, Zhejiang Province (Wu D A, 1994).

Comparison with the iron concentrations in other rivers in Amur basin, the iron concentrations in river in Sanjiang Plain are also higher than that(0.21mg/L in March, 2001 and 0.34mg/L in March, 2002) in Amur River near Blagoveshchensk, that (0.58 mg/L in March, 2001 and 0.66mg/L in March, 2002) in Zeya River near Blagoveshchensk, that (0.17mg/L in March, 2002) in Bureya River, that (0.70mg/L in March, 2002 and 0.57mg/L in Dec.,2002) in the Middle Amur River, that (0.67 mg/L in mean and 0.20-1.45mg/L in range in 1950-1975, 0.83mg/L in mean and 0.39-1.71mg/L in 1979-1987, 0.92mg/L in January, 2002 and 0.53mg/L in January 2004 in the middle Amur River near Khabarovsk(Schesterkin Vladimir P, 2004).

The mean Fe(II) concentration in rivers is 0.17mg/L (0.01- 0.80 mg/L) , and the mean Fe(III) concentration in rivers (Table 5 and Table 8) is 0.16mg/L (0.01- 0.95 mg/L). Total dissolved Mn is 0.021mg(0.010-0.217mg/L). The concentration of Fe(III) is lower than that[0.73mg/L(0.32-1.36mg/L)] in Naoli River and that [0.57mg/L (0.08-2.00mg/L)] in Songhua River in the period of 1962-1963. The Fe(II) concentration is close to that [0.21mg/L (0.08-0.40 mg/L)] in Naoli River in the period of 1962-1963, But lower than that [0.43mg/L (0.08-2.00mg/L)] in Songhua River in the period of 1962-1963.

Total dissolved Mn content is very low, the mean content is 0.021mg/L(0.010-0.217 mg/L) and 80% of sample contents are lower than the determining limit(0.010 mg/L). The concentrations are lower than the limited concentrations of Mn(0.1mg/L) in drinking water from surface water source in Environmental Quality Standard for Surface Water in China(GB3838-2002). The content is only 10% of that (0.27mg/L) in the rivers in Hangjiahu Plain, Zhejiang Province (Wu D A, 1994).

There are good positive relationships among total dissolved Fe, acid soluble Fe and DOC in river waters (Fig.4). Total dissolved Mn, Fe(II) and Fe(III) have bad relationships with other items in river.

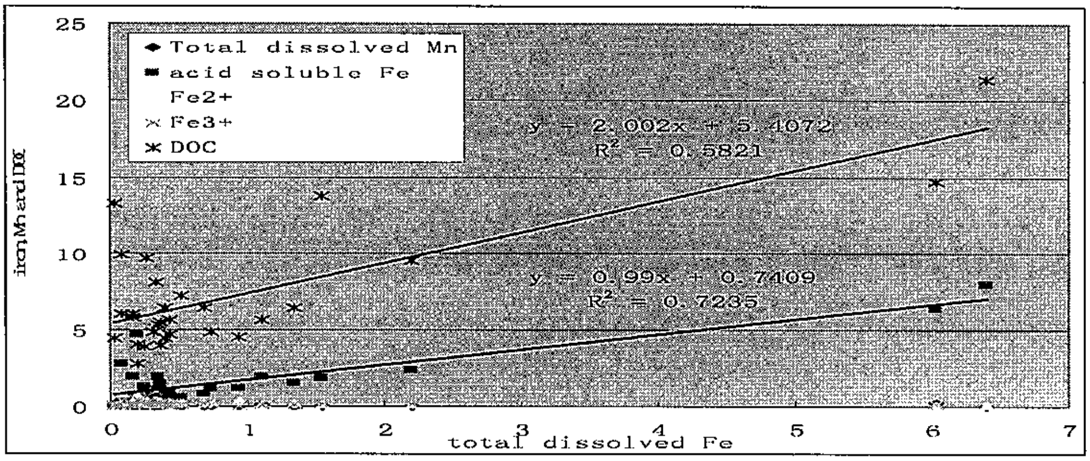

Fig. 4 Relationships between total dissolved iron and acid soluble iron, DOC in river

4.2.2 The concentration level of iron and manganese in ground water

The mean concentrations of total dissolved iron in ground water(Table 5 and Table 8) is 6.71mg/L(0.03-40.95mg/L), and the acid soluble iron is 8.74mg/L (0.03-44.05mg/L), which are much more than those in rivers in the plain. They are in same degree with those(2.57-4.84mg/L) in ground water from March,1999 to March,2001 in Pryamaya and Kazakevichevo sub-channels of Khabarovsk (Schesterkin Vladimir P, 2004). But they are higher than (0.04-2.18mg/L) in the ground water in the Second Songhua River basin (Xu X L, 2000) and that (0.33 mg/L) in shallow ground water in Hangjiahu Plain, Zhejiang Province (Wu D A, 1994).

The mean concentrations of Fe(II) in ground water is 4.46mg/L(0.01-20.5 mg/L), The mean concentrations of Fe(III) is 0.70mg/L(0.01-1.50mg/L), Mn is 0.620 mg/L (0.010-4.341mg/L). They are much higher than those in rivers in the plain. The contents of Fe(II) and Mn are also more than those(0.15 and 0.22 mg/L, respectively) in shallow ground water in Hangjiahu Plain, Zhejiang Province (Wu D A, 1994).

There are good positive relationships among total dissolved iron, acid soluble iron, total dissolved Mn and Fe(II) in ground waters(Fig.5, Fig.6, Fig.7). Fe(III) and DOC have bad relationships with iron and manganese in ground water.

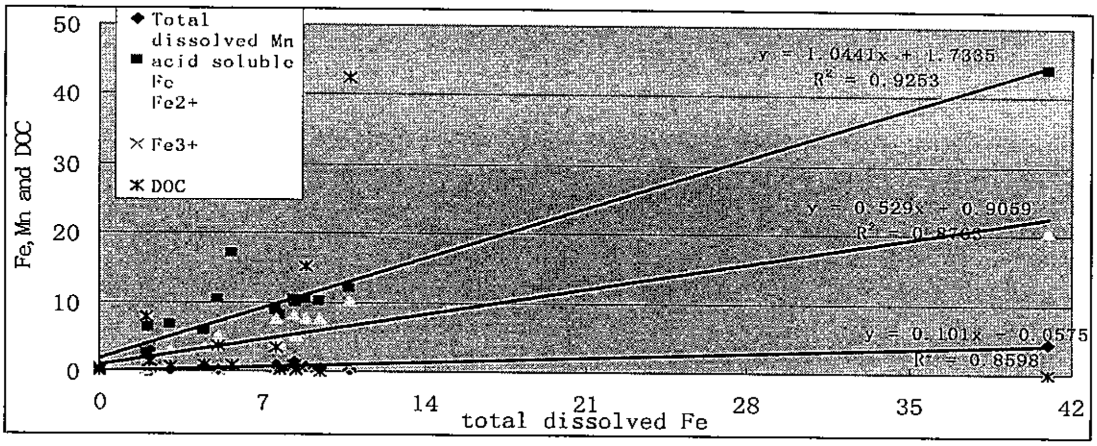

Fig. 5 Relationships between total dissolved iron and acid soluble iron, total dissolved Mn and Fe(II)

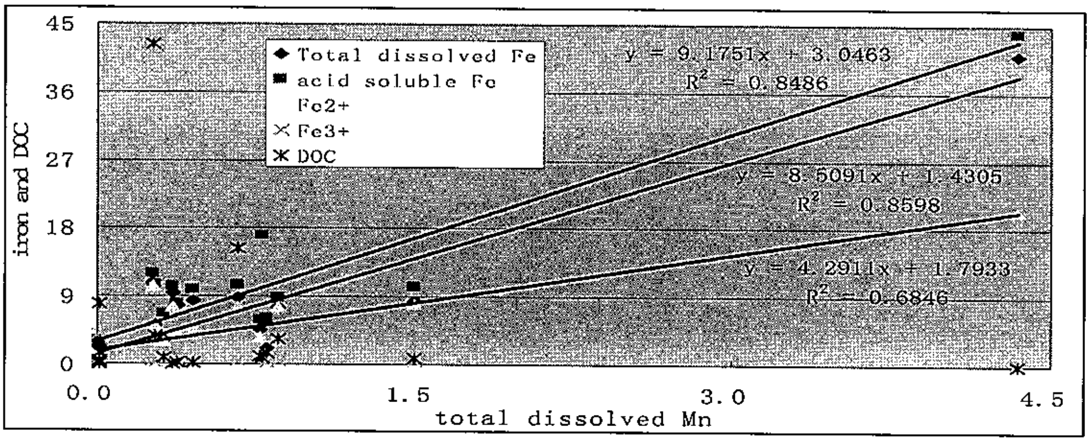

Fig. 6 Relationships between total dissolved Mn and acid soluble iron, total dissolved iron and Fe(II)

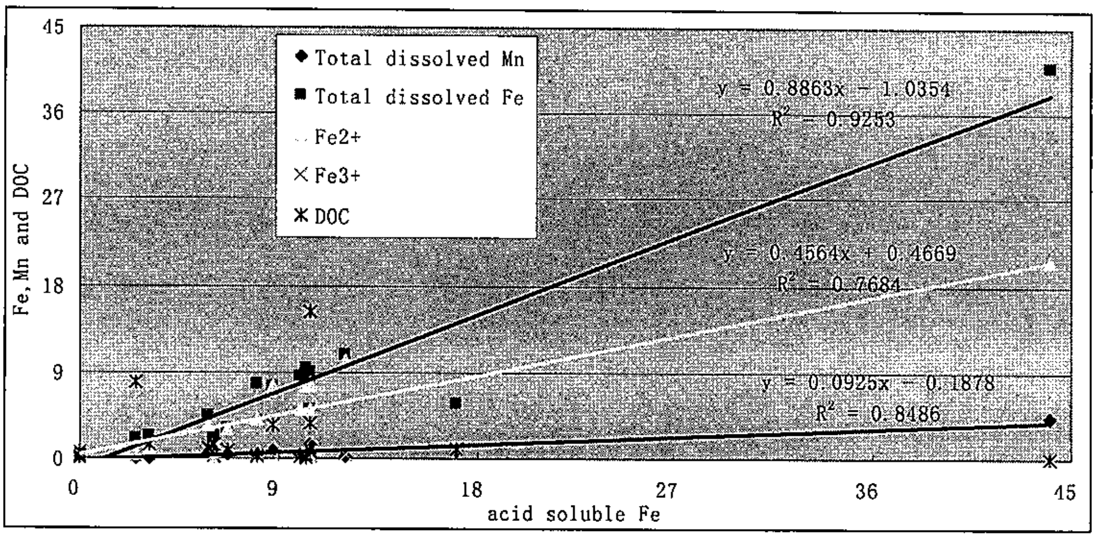

Fig. 7 Relationships between acid soluble iron and total dissolved iron, total dissolved Mn and Fe(II)

4.2.3 The concentration level of iron and manganese in agricultural drainage

The mean concentration of total dissolved iron in agricultural drainage(Table 8) is 1.32mg/L (0.03-8.29 mg/L), and the acid soluble iron is 1.83 mg/L(0.03-9.91 mg/L), which are higher than those in rivers, but lower than those in ground water in the plain.

The mean concentrations of Fe(II) in agricultural drainage is 0.15mg/L(0.04 -0.50mg/L), The mean concentrations of Fe(III) is 0.10mg/L(0.01-0.30mg/L), Mn is 0. 023mg/L (0.010-0.167mg/L). They are much lower than those in ground water, but very close to those in river water in the plain.

There are good positive relationships among total dissolved iron, acid soluble iron, total dissolved Mn and DOC in agricultural drainage (Fig.8, Fig.9, Fig.10, Fig.11). Fe(II) and Fe(III) have bad relationships with other items of iron and manganese and DOC in agricultural drainage.

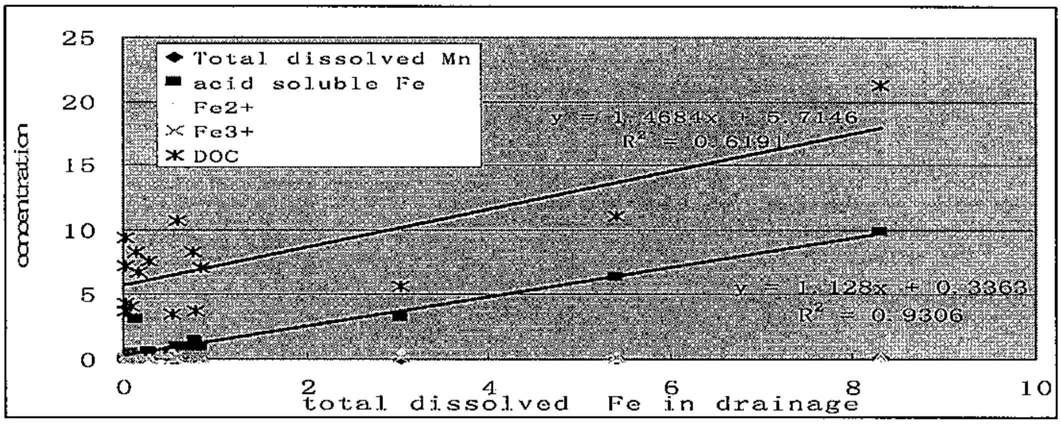

Fig. 8 Relationships between total dissolved iron and acid soluble iron, DOC in drainage

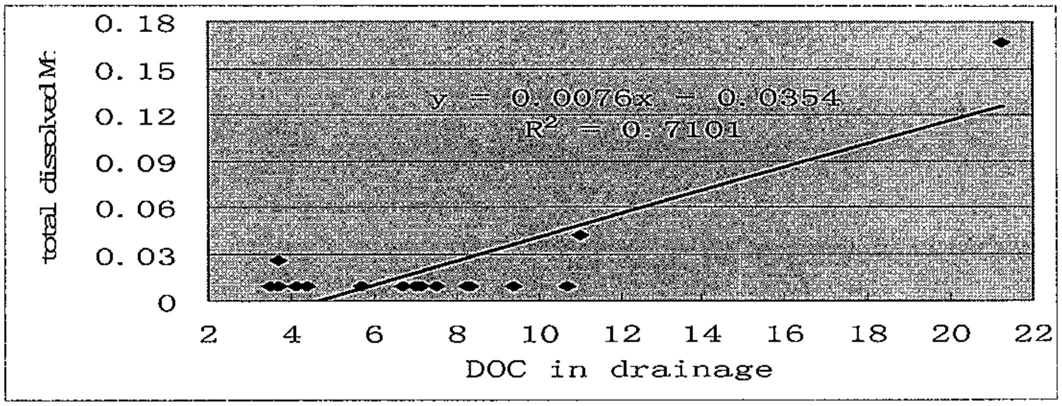

Fig. 9 Relationship between total dissolved Mn and DOC in drainage

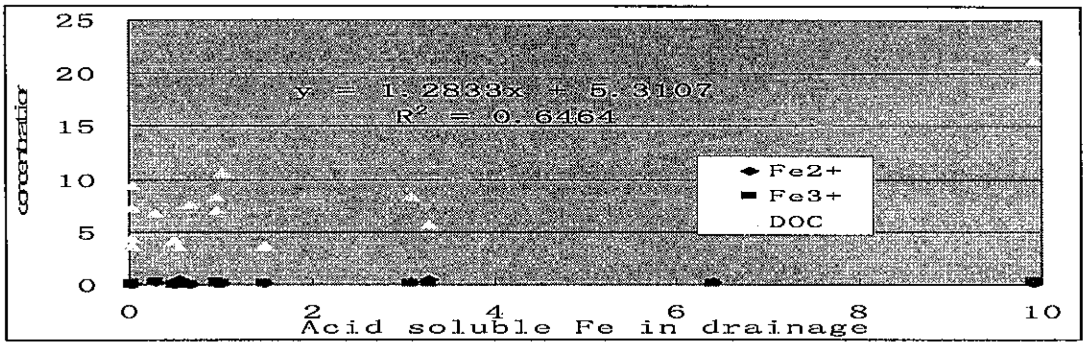

Fig. 10 Relationship between acid soluble iron and DOC in drainage

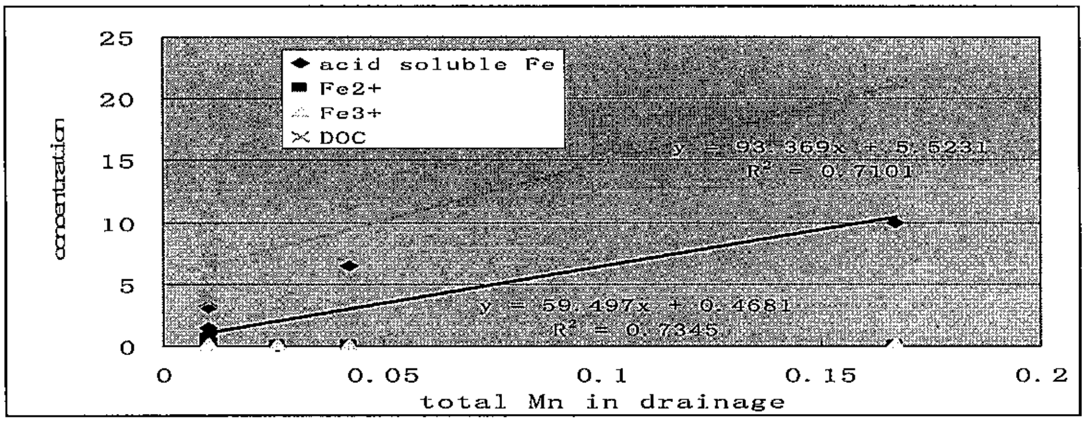

Fig. 11 Relationships between total dissolved Mn and acid soluble iron ,DOC in drainage

4.2.4 Seasonal change of iron concentrations

The concentrations of total dissolved iron, acid soluble iron and manganese in rivers in September are higher than those in August. The concentrations of Fe(II) and Fe(III) in rivers in September are lower than those in August, but the concentration are close to each other(Fig.12 left).

The concentrations of total dissolved iron, acid soluble iron and manganese in ground water in September are also higher than those in August, but the concentration are more close to each other. The concentrations of Fe(II) and Fe(III) in ground water in September are lower than those in August(Fig.12 middle).

All concentrations of total dissolved iron, acid soluble iron , manganese, Fe(II) and Fe(III) in agricultural drainage in September are more lower than those in August(Fig.12 right).

This phenomenon may contribute to seasonal change of river discharge and agriculture production activities. August 2005 is in the peak period of river flow and September 2005 is in the period of river mean flow. The floodwater may dilute the concentration of iron in rivers.

Another reason is that all irrigation activities will stop in the third part of August when rice will near mature season. So, no irrigation water were discharged into canals in September. The water in canals in September almost came from precipitation and runoff from upland field, which have relative lower concentrations of iron and manganese. Therefore, the concentrations in September are lower than those in August.

The concentrations difference of Fe(II), Fe(III) are not obvious in season. Also, the iron concentrations in ground water in September are close to those in August. From July 2005, the ground water level stop falling down and begin to rise slowly due to much precipitation and small pumping from aquifer. The ground water levels in August and September also were lifted slowly and relatively stable (Fig. 13). This may become the main reason for the small concentration difference.

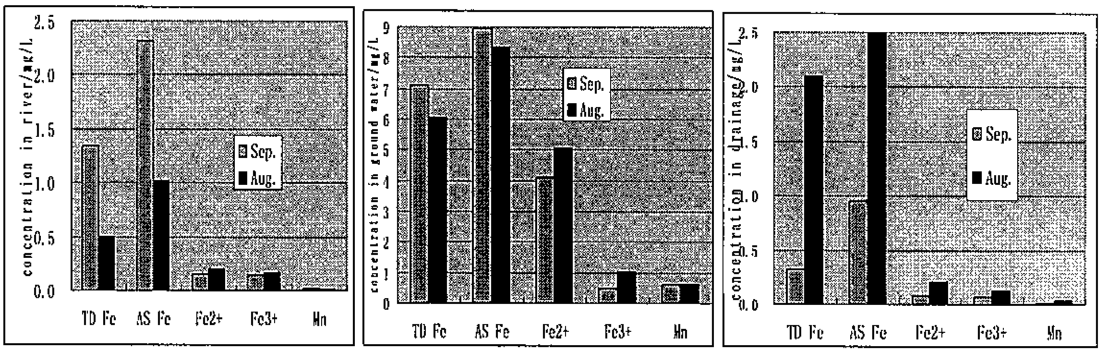

Fig. 12 Seasonal change of concentrations of iron and manganese in river, ground water and drainage

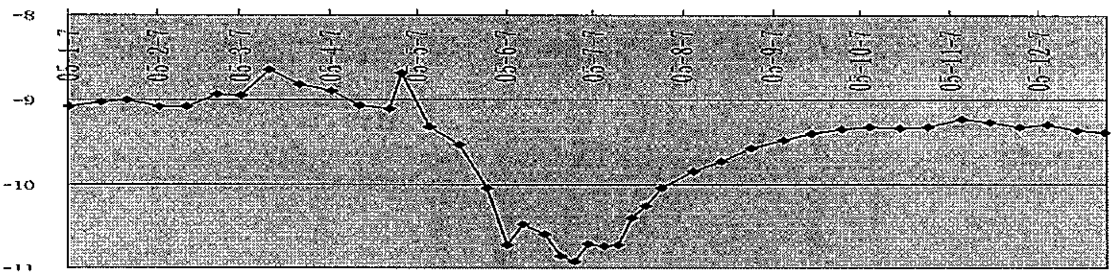

Fig.13 Ground water level variation in 2005 in Sanjiang Station

4.3 DOC

4.3.1 The concentration level of DOC in different kinds of water

The DOC concentration in rivers, agricultural drainage and ground water in Sanjiang Plain are 9.13mg/L(2.753-64.170 mg/L), 7.65 mg/L(3.534-21.120mg/L) and 4.25mg/L(0.03-42.37mg/L), respectively. The rivers had higher DOC concentration than drainage and ground water.

There are good relationship between DOC and total dissolved iron in river. DOC had a positive correlation with total dissolved iron, total dissolved manganese, acid soluble iron in drainage water.

4.3.2 Seasonal change of DOC concentrations

The DOC concentration in August were higher than those in September in river, ground water and agricultural drainage(Fig. 14). This result may be ascribed to the strong precipitation, great runoff and peak discharge of river in August, high water season. Due to more rain storm in July and August, organic matter can be carried out from paddy field, upland field , forest land and marsh land into canal system and river.

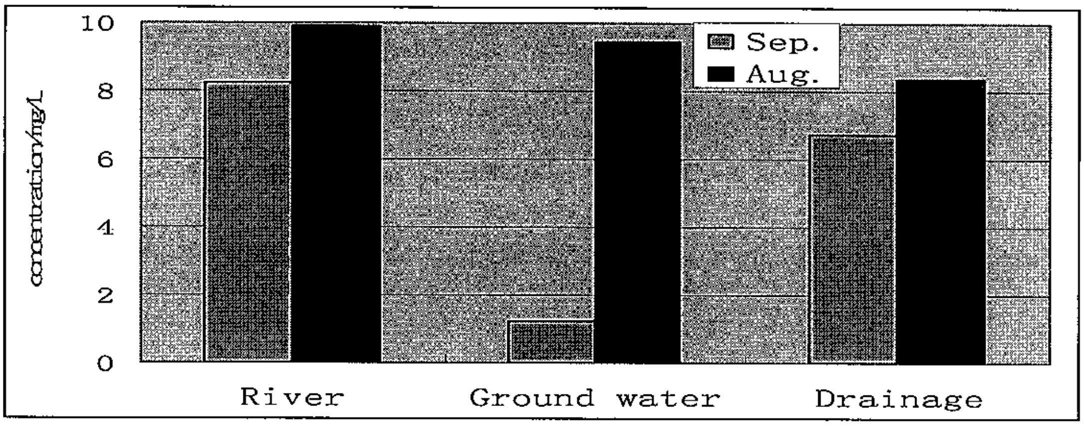

Fig. 14 Seasonal variation of DOC concentration in different kinds of water

4.4 Nitrogen, phosphorus and silicon

4.4.1 Concentration of N, P and Si in different kinds of water

The concentrations of NH_4^+-N were 0.029mg/L(0.005-0.236mg/L) in river, 0.465mg/L(0.005-1.423mg/L) in ground water and 0.166mg/L(0.005-1.105mg/L) in agricultural drainage, respectively(Table 9). The concentrations were highest in ground water and very low in river. This may has correlation with redox condition. The oxygen content is always low in ground water, so it is advantaged for NH_4^+-N to conserve.NO_3^--N had the same variation trend as NH_4^+-N, the concentration were 0.669mg/L(0.005-3.484mg/L) in river, 1.927mg/L(0.003- 20.104mg/L) in ground water and 0.418mg/L(0.005-2.050mg/L) in agricultural drainage, respectively(Table 9). But the variation for NO_2^--N is different with NH_4^+-N and NO_3^--N. Its concentration is highest in drainage(52.490μg/L) and lowest in ground water (9.144 μg/L). The concentration (15.547μg/L) in river is more than those in ground water. This may be ascribed to shallow water and rich oxygen in canals. Also, the bigger concentrations change, the bigger the range vary.

The differences of ortho-phosphate concentrations between three kinds of water are smaller. They are 0.095mg/L(0.005-0.782mg/L) in ground water, 0.065mg/L (0.005-0.317mg/L) in drainage and 0.042mg/L(0.003-0.419mg/L) in river, respectively (Table 9). A little higher concentrations were determined in ground water and a little lower concentrations in river.

The concentrations of SiO_2 were high in ground water and low in drainage. They are31.26mg/L(7.79-49.61mg/L), 15.60mg/L(0.32-25.91mg/L) in river and 9.96 mg/L(0.36-30.20mg/L) in drainage, respectively (Table 9).

4.4.2 Seasonal variation

The concentrations of NH_4^+-N, NO_3^--N and NO_2^--N in August were lower than those in September both in river, ground water and agricultural drainage (Fig. 15). But, the concentrations of ortho-phosphate and silicon are inverse with nitrogen. They are high in August than those in September both in river, ground water and agricultural drainage (Fig. 16). This result may correlate with water volume and suspended substance content. August is in the peak discharge stage. NH_4^+-N, NO_3^--N and NO_2^--N are easy to dissolve in water column. So, their concentrations are mainly decided to water discharge. Ortho-phosphate and Si mainly exist in particle-bound

Table 9 Nitrogen, phosphorus and silicon concentrations(mg/L) in river, ground water and agricultural drainage in Sanjiang Plain

element	month	River water		Ground water		Agricultural drainage	
		mean	range	mean	range	mean	range
NH_4^+-N	Sep.	0.051	0.005-0.236	0.406	0.005-1.366	0.293	0.005-1.105
	Aug.	0.011	0.005-0.051	0.566	0.047-1.423	0.067	0.005-0.321
	annual	0.029	0.005-0.236	0.465	0.005-1.423	0.166	0.005-1.105
NO_3^--N	Sep.	0.869	0.005-3.484	3.031	0.005-20.104	0.552	0.005-1.892
	Aug.	0.495	0.005-1.156	0.035	0.003-0.106	0.314	0.005-2.050
	annual	0.669	0.005-3.484	1.927	0.003-20.104	0.418	0.005-2.050
NO_2^--N (μg/L)	Sep.	21.596	0.500-72.828	10.230	0.500-25.578	54.793	0.500-157.502
	Aug.	10.254	0.262-27.165	7.283	0.500-26.477	50.698	1.016-303.980
	annual	15.547	0.262-72.828	9.144	0.500-26.477	52.490	0.500-303.980
PO_4^{3-}	Sep.	0.049	0.003-0.419	0.013	0.005-0.037	0.020	0.005-0.068
	Aug.	0.036	0.008-0.059	0.237	0.005-0.782	0.101	0.005-0.317
	annual	0.042	0.003-0.419	0.095	0.005-0.782	0.065	0.005-0.317
SiO_2	Sep.	12.32	0.32-25.91	27.15	7.79-42.04	7.68	0.36-15.07
	Aug.	18.47	1.65-23.35	38.31	30.77-49.61	11.74	0.94-30.20
	annual	15.60	0.32-25.91	31.26	7.79-49.61	9.96	0.36-30.20

form in water. Therefore, they has good relationship with great runoff and peak discharge of river.

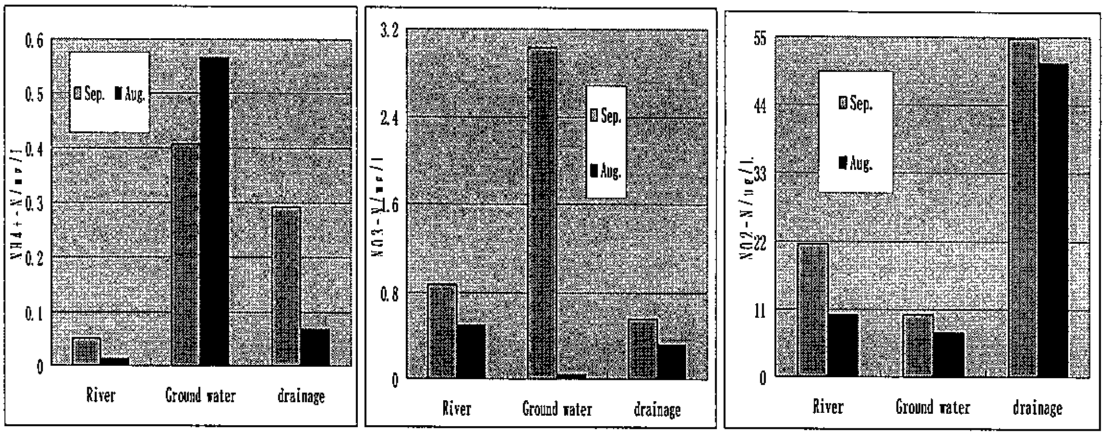

Fig. 15 Seasonal variation of nitrogen concentration in different kinds of water

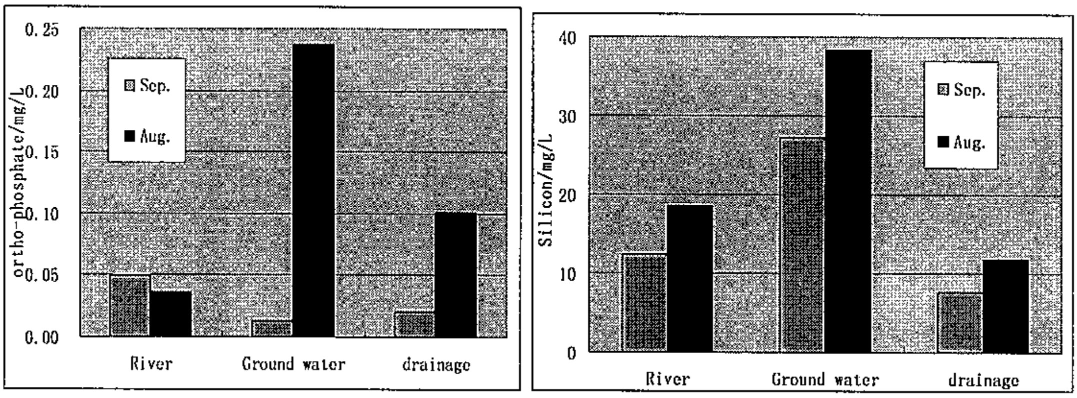

Fig. 16 Seasonal variation of ortho-phosphate and silicon concentration

4.5 Base cation and anion

4.5.1 Concentration of base cation and anion in different kinds of water

The concentrations of K were 0.979mg/L(0.050-2.397mg/L) in river, 1.090mg/L(0.731-6.424mg/L) in ground water and 2.353mg/L(0.765-8.011mg/L) in agricultural drainage, respectively(Table 10). K concentrations was higher in drainage than those in ground water and river.

The variation trends of Na, Mg and Ca are same. The concentration was higher in ground water than those in drainage and river. The concentrations of Na were 12.414mg/L(4.081-31.136mg/L) in river, 19.259 mg/L(6.713-31.577mg/L) in ground water and 15.211mg/L(4.466-39.537mg/L) in agricultural drainage, respectively. The concentrations of Mg were 5.541mg/L(2.808-9.820mg/L) in river, 10.724 mg/L (4.753-20.298mg/L) in ground water and 7.758mg/L(1.763-18.474mg/L) in agricultural drainage, respectively. The concentrations of Ca were 17.911mg/L(5.223 -63.152mg/L) in river, 34.120mg/L(12.134-61.670mg/L) in ground water and 18.742mg/L(3.458-34.266mg/L) in agricultural drainage, respectively (Table 10).

Rainfall and runoff are the main sources of river water and ground water. In the process of runoff infiltrating through soil and mother material layers into the aquifer, many cation will be dissolved from minerals into water. So, the cation concentrations always are higher than those in surface water. Ca is the dominant ion in cation. Mg is the second dominant ion in cation. K is spare in ground water.

Bicarbonate is the dominant ion and chlorine is the second dominant ion in anion. Sulphate and nitrate are relatively spare in ground water.

The concentrations of bicarbonate were 92.37mg/L(36.60-161.04mg/L) in river, 180.59mg/L(76.13-264.76mg/L) in ground water and 125.45mg/L(29.28-285.48mg/L) in agricultural drainage, respectively(Table 10). Bicarbonate concentrations was higher in ground water than those in drainage and river. The change dynamics are close for chlorine and sulphate. The concentrations are higher in river and ground water than those in drainage. For nitrate, the concentrations are highest in ground water (8.536mg/L) and lowest in drainage(1.852mg/L).

4.5.2 Seasonal variation

The concentrations of all base ions, except chlorine in drainage, in August were lower than those in September both in river, ground water and agricultural drainage (Fig. 17). This result also may correlate with water volume. August is in the peak discharge stage. All cation and anion are easy to dissolve in water column. So, their concentrations are mainly decided to water discharge.

Table 10 Basic cation and anion concentrations(mg/L) in river, ground water and agricultural drainager in Sanjiang Plain

element	month	River water		Ground water		Agricultural drainage	
		mean	range	mean	range	mean	range
K	Sep.	1.159	0.050-2.397	1.279	0.731-6.424	2.821	0.765-6.390
	Aug.	0.821	0.763-1.046	0.765	0.764-0.766	1.990	0.766-8.011
	annual	0.979	0.050-2.397	1.090	0.731-6.424	2.353	0.765-8.011
Na	Sep.	14.610	4.081-31.136	20.150	6.713-31.577	16.326	8.456-39.537
	Aug.	10.493	4.668-19.270	17.732	7.990-25.182	14.343	4.466-34.782
	annual	12.414	4.081-31.136	19.259	6.713-31.577	15.211	4.466--39.537
Mg	Sep.	6.222	3.156-9.820	11.774	6.321-20.298	8.774	5.963-18.474
	Aug.	4.945	2.808-7.306	8.924	4.753-15.278	6.967	1.763-14.042
	annual	5.541	2.808-9.820	10.724	4.753-20.298	7.758	1.763-18.474
Ca	Sep.	25.766	7.877-63.152	41.336	15.061-61.670	24.208	7.697-34.266
	Aug.	11.037	5.223-17.387	21.751	12.134-39.625	14.491	3.458-30.449
	annual	17.911	5.223-63.152	34.120	12.134-61.670	18.742	3.458-34.266
HCO_3^-	Sep.	115.36	65.88-161.04	200.95	117.12-256.20	154.77	95.16-285.48
	Aug.	72.25	36.60-126.78	145.69	76.13-264.76	102.65	29.28-260.84
	annual	92.37	36.60-161.04	180.59	76.13-264.76	125.45	29.28-285.48
Cl^-	Sep.	16.99	1.15-85.28	15.41	0.23-55.54	10.00	1.42-43.73
	Aug.	14.55	9.94-23.08	15.21	8.88-40.82	15.90	10.65-28.40
	annual	15.69	1.15-85.28	15.34	0.23-55.54	13.32	1.42-43.73
SO_4^{2-}	Sep.	2.13	0.06-8.23	1.78	0.06-10.65	1.20	0.14-4.72
	Aug.	1.15	0.05-2.44	1.24	0.05-6.97	0.90	0.05-4.90
	annual	1.61	0.05-8.23	1.58	0.05-10.65	1.03	0.05-4.90
NO_3^-	Sep.	3.846	0.022-15.429	13.424	0.022-89.032	2.445	0.022-8.379
	Aug.	2.190	0.022-5.119	0.156	0.013-0.469	1.392	0.022-9.079
	annual	2.963	0.022-15.429	8.536	0.013-89.032	1.852	0.022-9.079

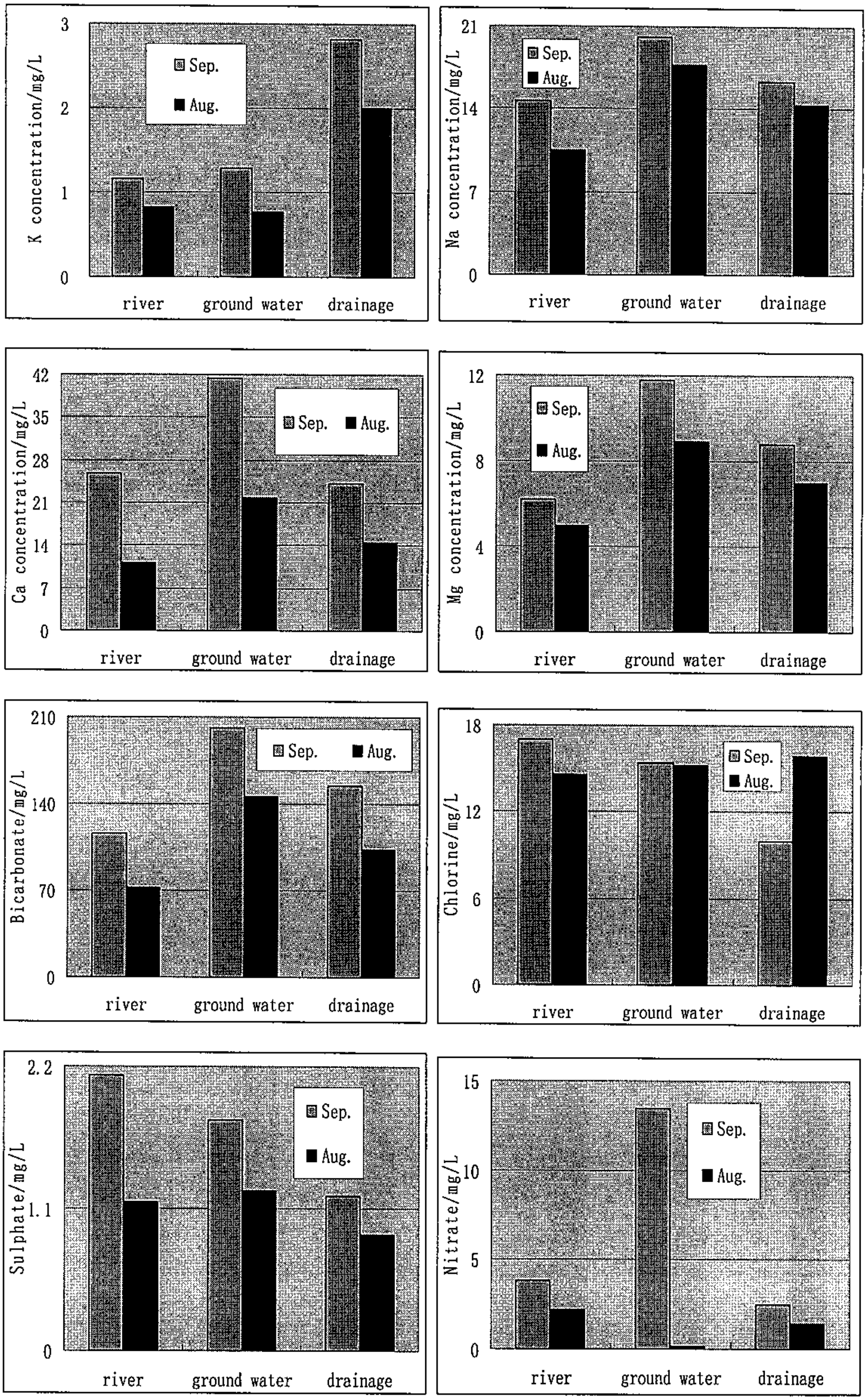

Fig. 17 Seasonal variation of base cation and anion in different kinds of water

4.6 pH, EC, salinity and turbidity

4.6.1 Concentration

pH is 7.18(6.50-7.54) in river water, 7.17(6.41-7.59) in ground water and 7.29(7.13-7.64) in agricultural drainage in September(Table 11). pH value in river is close to pH value in ground water, but pH in drainage is little high.

Salinity are 0.002%(0-0.02%) in river water, 0.013% (0-0.077%) in ground water and 0.003%(0-0.02%) in agricultural drainage(Table 11). Salinity is high in ground water, low in drainage and river.

EC are 0.179ms/cm(0.001-0.820ms/cm) in river water, 0.365ms/cm (0.171-1.121ms/cm) in ground water and 0.202 ms/cm (0.062-0.419 ms/cm) in agricultural drainage(Table 11). EC is high in ground water than those in drainage and river.

Turbidity are 175NTU (1-999NTU) in river water, 118NTU (3-350NTU) in ground water and 38NTU (5-234 NTU) in agricultural drainage(Table 11). Turbidity is high in river and ground water than that in drainage.

4.6.2 Seasonal change

Salinities in September are higher than those in August both in river, ground water and agricultural drainage. But EC and turbidity in August are higher than those in September(Fig. 18). This result also may correlate with water volume. August is in the peak discharge stage. There are more suspended substance in water than other season. So, turbidity is high in flood period. The seasonal change of salinity is same with cation and anion.

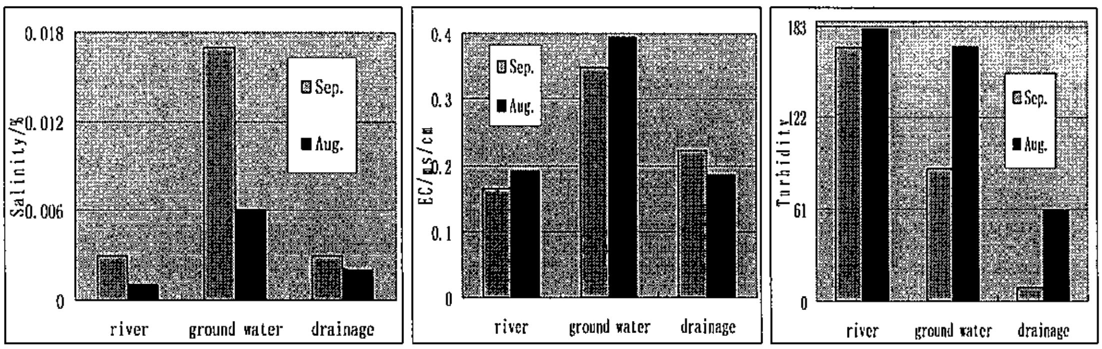

Fig. 18 Seasonal variation of base cation and anion in different kinds of water

Table 11 EC, pH, WT, SAL and TURB in river, ground water and agricultural drainage in Sanjiang Plain

element	month	River water		Ground water		Agricultural drainage	
		mean	range	mean	range	mean	range
WT(℃)	Sep.	20.7	18.5-23.2	8.2	6.3-10.2	20.8	17.3-23.5
	Aug.	25.0	24.3-26.5	7.9	7.3-8.5	25.2	23.1-26.0
	Annual	23.0	18.5-26.5	8.1	6.3-10.2	23.3	17.3-26.0
SAL(%)	Sep.	0.003	0-0.01	0.017	0-0.07	0.003	0-0.02
	Aug.	0.001	0-0.02	0.006	0-0.04	0.002	0-0.02
	Annual	0.002	0-0.02	0.013	0-0.07	0.003	0-0.02
pH	Sep.	7.18	6.50-7.54	7.17	6.41-7.59	7.29	7.13-7.64
EC (ms/cm)	Sep.	0.165	0.001-0.333	0.348	0.171-0.515	0.222	0.129-0.419
	Aug.	0.191	0.066-0.820	0.395	0.232-1.121	0.185	0.062-0.373
	Annual	0.179	0.001-0.820	0.365	0.171-1.121	0.202	0.062-0.419
TURB (NTU)	Sep.	168	10-999	88	10-350	9	5-10
	Aug.	181	1-999	169	3-291	60	10-234
	Annual	175	1-999	118	3-350	38	5-234

5 Suggestion

5.1 Catchment study

To estimate the flux of different forms iron, it is helpful to do the research in catchment scale. Nongjiang River is an ideal catchment to actualize the study. There are nature marsh land (Honghe Nature Reserve), upland field, paddy in the catchment. Large scale reclamation took place in 1980's. Before the 1980's, almost landscape in the basin was marsh land, meadow land and island forest.

The different plots of upland, paddy and marsh, meadow can be chose. The research in plots should connect all factors, including rain, runoff, ground water(pumped for irrigation) , soil interstitial water, etc. Also,atmosphere, soil, ground water and surface water will be contacted by the flow of water and iron. River is the acceptor of iron by agricultural drainages systems. Moreover, there were some hydrology, meteorology and land use data and information. So, researcher objective may be favourably approached in this kind of catchment.

5.2 Water chemistry research in key sections of river, drainage canal

In the year of 2005, water samples were collected only two times. They show the water chemistry of flood season and mean season. For Sanjiang Plain, the snow thaw water in spring (April) is important for river hydrology and ground recharge. So, it is also significant for elements transportation into river and sea. There are about five months snow-covered period for soils and four months ice-covered period for river. This kind of close condition may impact on the redox of river water and bioactivity in sediment , shallow ground water and soils. Forms and removal ability of elements will be affected certainly. Therefore, collecting water samples from key sections of river, drainage and some wells for one more year in different seasons, including flood season , mean season, low season and ice-covered season, are necessary to know the change of concentration and forms. Also, it is helpful to estimate the flux of element transportation through the river system.

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