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Meteorological Disasters in the Sanjiang Plain, Northeast China

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Abstract

Cool weather damage, frost injuries, floods, droughts and strong wind damage were investigated as typical meteorological disasters occurred during the 36 years after 1950 in the Sanjiang Plain. Records of the disasters were assembled from numerous scientific reports and books published in China and listed in a regular time series.

The Sanjiang Plain suffered cool weather damages twelve times and floods and droughts seven times during the period. The areas which were damaged by strong winds have increased rapidly in the last 20 years. A power spectral analysis indicates that there is some periodicity in the year to year fluctuations of thermal conditions and precipitation.

Key Words: Meteorological disaster, Cool weather damage, Flood, Drought, Wind damage, Land use, Agricultural development, Nature conservation, The Sanjiang Plain in China.

1. Introduction

The interaction between the atmosphere, water, ground and living organisms is somewhat changeable but not unstable in natural, undisturbed conditions except when such under strong impact of diastrophisms and climatic changes. The response of the natural ecosystem to new agricultural land use and the counter action from the natural ecosystem to agriculture are very interesting problems for environmental and natural disaster science.

In the Sanjiang Plain, about 275 millions hectares of cultivated land were developed during only 30 years since 1949. The area corresponds to about 33 percent of total the area of the plain and 2.6 times the total area of cultivated land in Hokkaido, Japan.

For the natural ecosystem, such as vegetation, soil and climate, researchers of the Department of Marsh Research, Changchun Institute of Geography, have pointed out the problems caused by such hasty agricultural development.

Li, C. et al. (1981) reported the drastic decrease in marsh meadows in the plain with increases in cultivated land from a comparative study of maps of land use in 1974 and 1978, the latter obtained from satellite data. They have warned that if cultivated lands areas increase at the present rate, wind erosion, which sometimes occurs near Luobei and Suibin in the northern area of the plain, will spread to the whole of the plain. On the other hand, Liu, X. (1983, 1984) reported that solar energy resources are sufficient for the growth of crops in the plain, and suggested effective energy use for agriculture and highly developed techniques of cultivation and land management.

Based on the reports mentioned above, Liu, Z. (1984) and He, W. (1984) proposed that land use in the Sanjiang Plain be: first, based on scientific surveys and foundations; second, aimed at land reclamation to achieve high productivity but not at development of more cultivated land; and third, ponds and swamps should be conserved as far as possible to preserve fishery resources and to prevent water and wind erosion in the plain.

In this preliminary study, a chronology of meteorological disasters was compiled to make clear the effects of the drastic developments on the ecosystem and the counter action of the natural ecosystem on agriculture for further studies. Records of meteorological disasters and climatic data in the Sanjiang Plain were collected from reports, books, and climatic tables published in China and were compared with data for Hokkaido, Japan.

2. Location and topography of the Sanjiang Plain

The Sanjiang Plain is located in the extreme northeast China, 45°1′N to 48°28′N and 130°13′E to 135°5′E. The plain borders on the U. S. S. R. to the north and east with the Heilong (Amur) R. and Wusuli (Ussuri) R. forming the border. Sonhua R. flows through the northwestern part of the plain to Heilong R.. The greater part of the plain is formed by alluvial from the three rivers.

The Wanda Mts. are southeast of the plain. There are numerous monadrocks, 80–150 m in relative elevation throughout the plain. The west part of the plain has the relatively high elevation of 60–80 m. The total area of the plain is 51,300 km^2 when excluding the area of the Wanda Mts..

3. Climate of the Sanjiang Plain

a. Temperature

Accumulated temperature above 10°C is widely used in China to indicate the thermal conditions for plant growth. The same method is used in Japan, but here several threshold temperatures of 0, 5, 10 and 12°C, are used in the accumulation. The distribution of annual mean temperature and accumulated temperatures above 10°C in the Sanjiang Plain are shown in Figures 2 and 3.

The southwestern part of the plain has the highest annual temperature, above

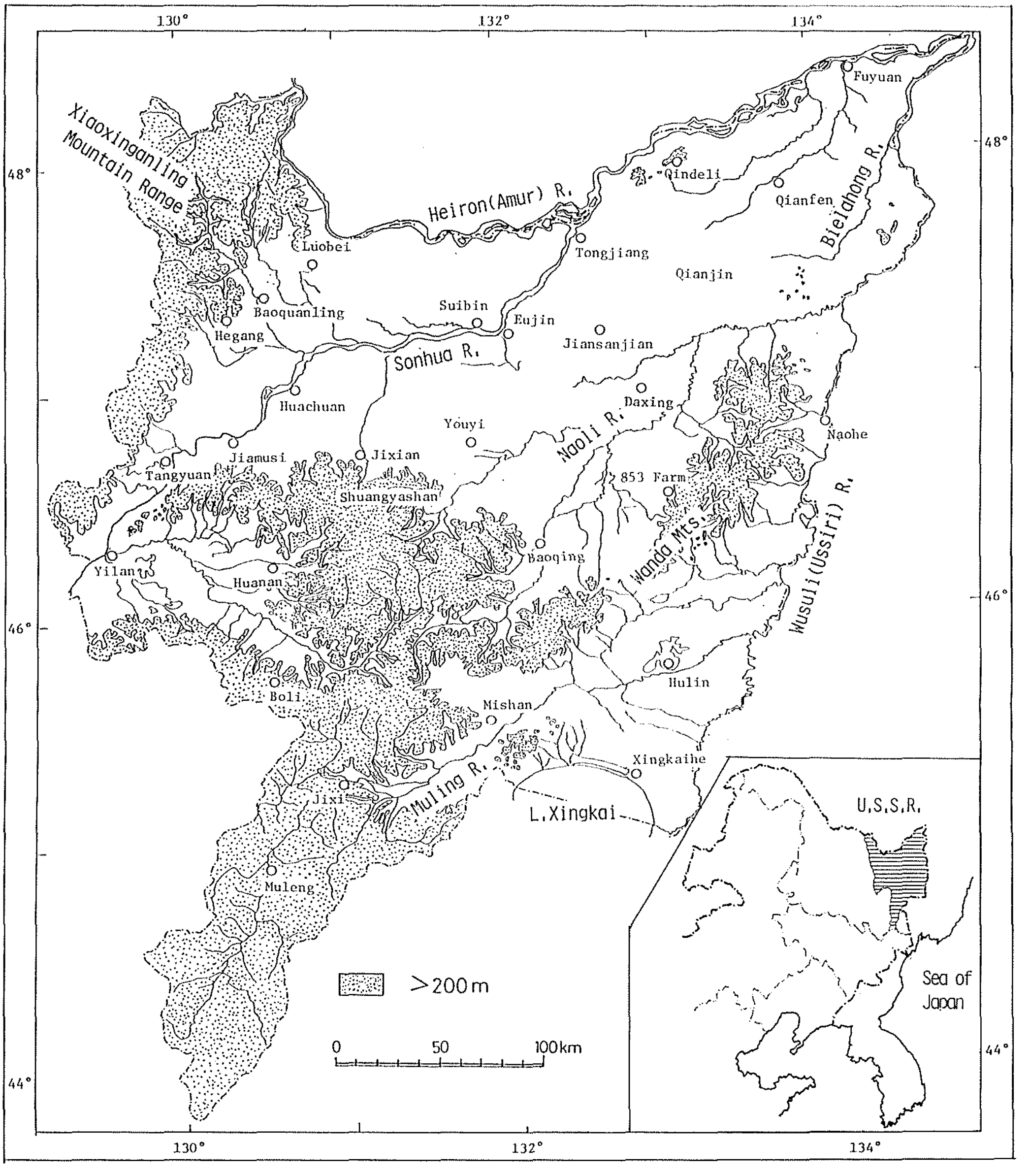

Figure 1. Topography of the Sanjiang Plain.

3.0°C, and in the northern part near Tongjiang and Qianjin it is below 1.5°C.. The Distribution of accumulated temperature shows almost the same pattern as that of the annual mean temperature, but the regions with the highest accumulated temperature shifts to the northwestern part of the plain near Jixian. This may be caused by long sunshine duration in spring and summer in this region. The accumulated temperature of the southwestern half of the plain is above 2500°C, which corresponding to Asahikawa (2590°C) and Obihiro (2475°C) in Hokkaido. The northeastern part of the plain, Qianjin, Naohe, and Fuyuan have lower ac-

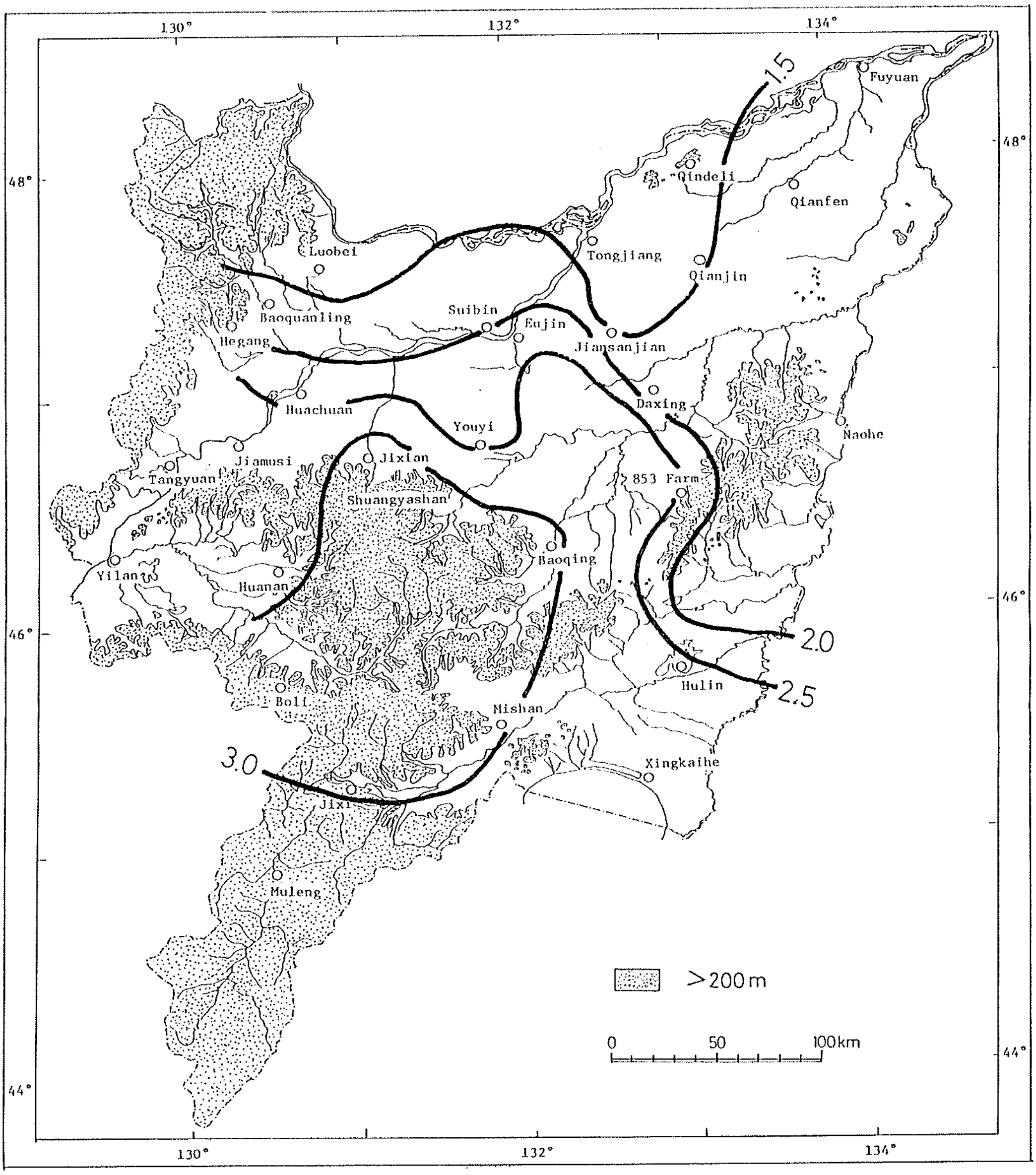

Figure 2. Annual mean temperatures (°C) in the Sanjiang Plain. Compiled from the figures by DMCIGAS (1983).

cumulated temperatures, below 2300°C, corresponding to Abashiri (2264°C) in Hokkaido.

The frost free period, which indicates the climatic condition when plant growth is possible, is between 120–145 days in the plain. The south-western part, Jixian, Baoqing, and Mishan, has a relatively longer frost free period, above 140 days, and the northern area, Fuyuan, Naohe, and Luobei, has a shorter period, below 125 days. The frost free periods in the plain are about 20 days shorter than in

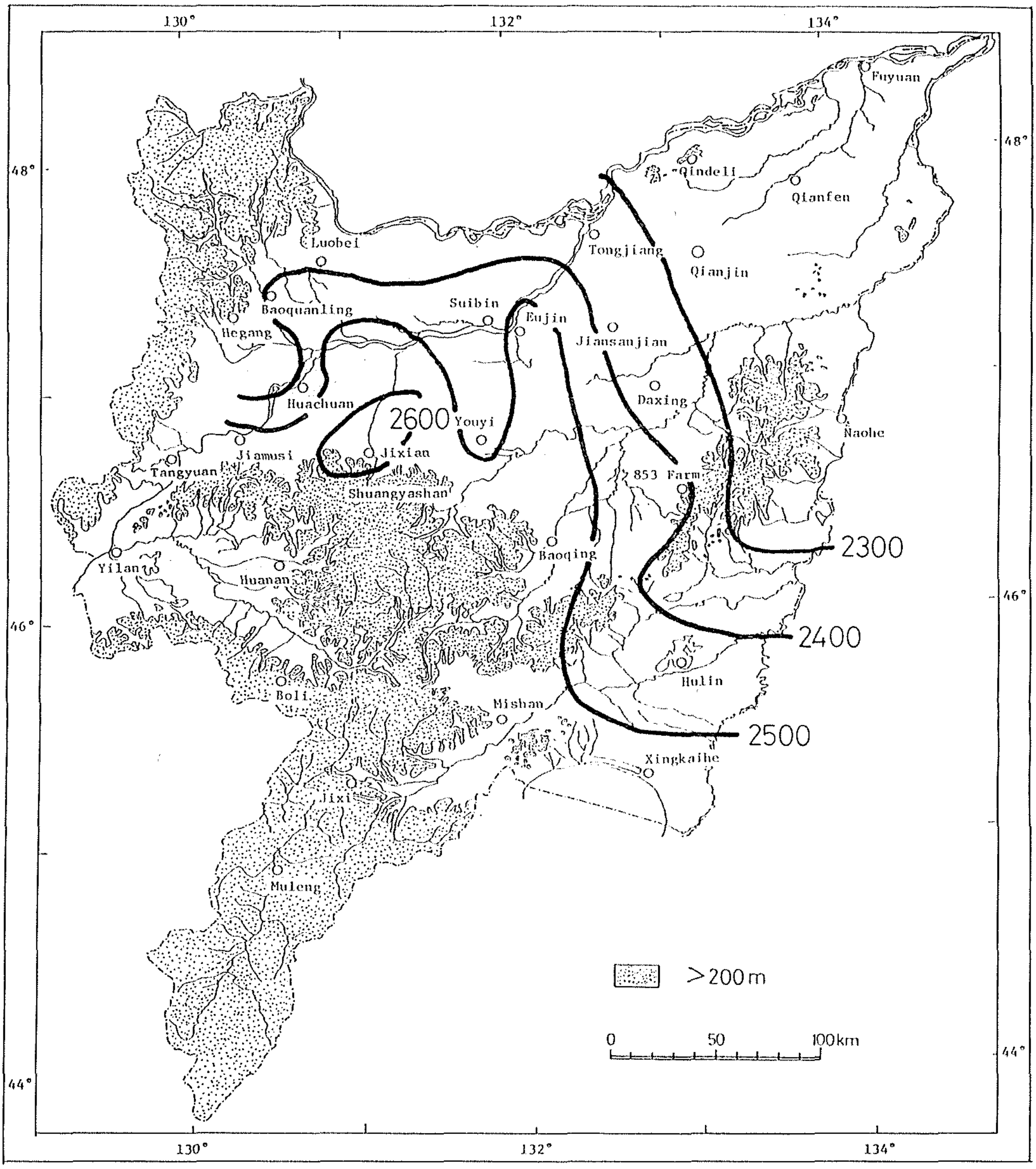

Figure 3. Accumulated temperatures (°C) above 10°C in the Sanjiang Plain. Compiled from the figures by DMCIGAS (1983).

Hokkaido.

An extremely cold winter is one of the climatic characteristics of the Sanjiang Plain. Monthly values of mean temperatures, precipitation, maximum wind speeds and maximum depth of snow cover at Fujin are shown in Table 1. Extremely cold winter and thin snow cover, −19.9°C in January and 7 cm in February, at Fujin makes soil freeze deep. Maximum depths of soil freezing increase from 150 cm in the east to 210 cm in the west of the plain (Wang, J. et al., 1963). The

Table 1. Climatic table for Fujin (1961–1979, 47°14′N, 131°59′E, 64.2 m)

Month	Mean Temperature (°C)	Precipitation (mm)	Maximum Wind Speed (m/sec)	Maximum Depth of Snow Cover (cm)
Jan.	−19.9	3.0	11.1	6
Feb.	−16.6	4.3	12.3	7
Mar.	−6.0	7.9	13.9	6
Apr.	4.9	23.7	15.0	4
May	13.0	43.2	14.3	
Jun.	18.6	77.1	11.7	
Jul.	21.9	106.8	10.3	
Aug.	20.1	112.5	10.2	
Sep.	14.1	58.9	12.9	
Oct.	4.9	29.0	14.3	2
Nov.	−7.3	10.1	13.2	6
Dec.	−17.6	6.2	12.9	7
Annual	2.5	482.7	15.0	7

Table 2. First and last days of soil freeze in the Sanjiang Plain (after Wan, J. et al., 1963)

Station	First Day					Last Day				
	5 cm	10 cm	20 cm	30 cm	50 cm	5 cm	10 cm	20 cm	30 cm	50 cm
	Nov.	Nov.	Nov.	Nov.	Nov.	Mar.	Apr.	Apr.	Apr.	Apr.
Fujin	3	7	13	17	21	28	5	11	14	16
Naohe	7	7	13	18	22	8	12	17	17	20
Jiamusi	2	8	10	24	28	27	29*	2	4	4
Hulin	7	12	18	21	—	31	3	7	11	—

* Mar.

first and last days of soil freezing are different throughout the plain as shown in Table 2. At 5 cm depth they are 2–7 November and 8–31 March.

b. Precipitation

The amount of precipitation is between 500–650 mm but varies very much with the seasons. Total precipitation from April to September, which affects plant growth, reaches 87 percent of the annual precipitation. Precipitation in spring, April and May, is somewhat lower than in autumn, September and October.

The mountainous areas northwest of Luobei and the southern slope of the Wanda Mts. are wetter than the low plains because wet and warm southeastern air brings orographic rainfall. Areas near Huachuan, Jixian and Suibin are the driest in the plain because of the rain-shadow effect of the Wanda Mts..

The standard deviation of the annual precipitation shows a year to year varia-

Table 3. Variability of annual precipitation in the Sanjiang Plain (after DMCIGAS, 1983)

Station	Spring Apr., May	Summer Jun.–Aug.	Autumn Sept., Oct.	Annual
Fuyuan	26.4%	24.3%	31.2%	15.1%
Tongjiang	39.9	25.8	47.3	19.8
Luobei	45.3	21.9	41.3	18.3
Baoquanling	41.2	18.1	46.0	18.2
Jiansanjiang	18.9	17.9	33.8	18.2
Qianwei Farm	31.8	22.4	28.5	14.2
Fujin	33.1	17.3	39.8	17.2
Jixian	30.0	20.3	38.1	15.8
Youyi	33.4	14.9	32.7	15.1
The 853 Farm	33.8	20.8	43.2	17.1
Jiamusi	22.7	19.2	26.1	13.5
Naohe	19.5	13.8	20.6	10.8
Baoqing	24.9	21.6	35.6	20.6

bility in precipitation which may be used as drought and flood indexes too. Table 3 shows the variability of precipitation derived from the standard deviation of annual and seasonal precipitation except in winter on the Sanjiang Plain. Luobei, Baoquanling, and Tongjiang are prone to drought with the high variability in precipitation in spring. Fuyuan, Tongjiang, and Qianwei Farm are in danger of both droughts and floods with their high variability in precipitation in summer.

c. Wind

During the winter, cold westerly and northwesterly winds blow over the plain from the Mongolian High. Southeasterly winds previal during summer because warm and wet air blows from the North Pacific High to the Indian Low which is a semi-permanent thermal low pressure area stretching from the Indian Peninsula to the Northwest China. These are typical wind systems in monsoon Asia. In spring and autumn, when the prevailing wind systems change, there are strong winds as shown in Table 1.

Ground surface winds affected by relief features are called local winds or orographic winds. There are many local winds in Japan, because of the complicated lay of the land. In the Sanjiang Plain, there are a few local winds. Southwesterly winds prevail throughout the year at Jiamusi where the Xiaoxinganling Mountain Range and the Wanda Mts. form a wide valley along the Sonhua R. from southwest to northeast. The prevailing winds at Fuyuan is southwest in winter because of the Heilong R. running from southwest to northeast.

d. Climatic division

The climate in China outside Tibet is divided into nine temperature zones by the number of days that exceed 10°C, accumulated temperature above 10°C, and the monthly mean temperature in January, as shown in Table 4. The temperature zones are then subdivided on the basis of an aridity index considering the annual rate of evaporation and precipitation as shown in Table 5. Monthly mean temperatures in July are used as a second order subdivision.

In the Sanjiang Plain, the number of days exceeding 10°C are from 144 to 155 days, making the plain meso-thermal (II). The aridity indexes of the north and east parts of the plain are 0.9, putting it in the humid zone (A), and July mean temperatures range from 20°C to 22°C(Tc). Consequently, the climate of the Sanjiang Plain is divided into two climatic zones, IIATc and IIBTc.

Table 4. Climatic divisions in China (after ECNGC, 1984)

Climatic Zone		Number of Days above 10°C	Accumulated Temperature above 10°C	Monthly Mean Temperature for January
I	Microthermal	<100 days	<1600°C	<−30°C
II	Mesothermal	100—171	1600— 3400	−30— −6
III	Thermal	171—218	3200— 4800	−12— 0
IV	North Subtropical	218—239	4500— 5300	0— 4
			3500— 4000	3— 5
V	Meso-subtropical	239—285	5100— 6500	4— 10
			4000— 5000	5— 10
VI	South Subtropical	285—365	6400— 8000	10— 15
			5000— 7500	9— 15
VII	Peri-subtropical	365	8000— 9000	15— 20
			7500— 8000	14— 15
VIII	Meso-tropical	365	9000—10000	20— 26
IX	Tropical	365	>10000	>26

Table 5. Climatic subdivisions in China (after ECNGC, 1984)

Climatic Subzone		Annual Aridity Index	Natural Landscape
A	Humid	<1.0	Forest
B	Sub-humid	1.0— 1.6	Forest Steppe
C	Sub-arid	1.6— 5.0	Steppe
D	Arid	5.0—15.0	Semi-desert
E	Extreme Arid	>15.0	Desert

Table 6. Second order climatic subdivisions in China (after ECNGC, 1984)

Second Order Climatic Subzone	Monthly Mean Temperature for July
Ta	<18°C
Tb	18—20
Tc	20—22
Td	22—24
Te	24—26
Tf	26—28
Tg	>28

4. Meteorological disasters in the Sanjiang Plain

a. Chronology of meteorological disasters

There are different kinds of disasters caused by unusual weather. Floods, drought, water erosion, landslides, heavy snow, and avalanches may be listed as disasters due to precipitation. Cool weather damage, cold water damage, freezing damage, frost damage, and frost heaving damage are disasters due to temperature. Changes in land use occasionally brings new meteorological disasters, and through an analysis of meteorological disasters caused by the human impact on the land, it is possible to determine environmental problems.

This paper deals with drought, flood, cool weather damage, frost damage, and damage from strong winds as typical meteorological disasters in the Sanjian Plain. Serious disasters since 1950 were compiled from reports and books published in China and listed in a regular time series in Table 7.

The occurrence of meteorological disasters may be closely related to short term climatic changes. According to historical reports, the water level of the Lake Xingkai, and meteorological records, climate in the most recent 100 years period in the Sanjiang Plain has fluctuated periodically between dry and wet, and warm and cold as shown in Table 8.

b. Meteorological disasters due to temperature

—Cool weather damage—

The accumulated temperature is not completely adequate for crop growth in the Sanjiang Plain like in Hokkaido. Therefore, cool weather damage occurred frequently in the plain, at least twelve times during the thirty six years since 1950, as shown in Table 7. Among these the damages in 1957, 1969, and 1972 were very severe. In Hokkaido, there was cool weather damage eleven times during the same period as shown in Table 9. Five occurred simultaneously in both the Sanjiang Plain and Hokkaido in 1954, 1964, 1966, 1969, 1971, and 1976. The year to year fluctuation in the crop situation index in the plain is not clear due to a lack of statistical data. For example, Ding, S. (1983) reported that mean total production of grains and beans in the five cool summer years of 1954, 1957, 1969, 1972 and 1976 showed 25–30 percent decreases in the plain. And also reported a short term periodicity of 3.18 years and a long term periodicity longer than 70 years in the southern part of Northeast China, with short term periodicity in the area near Jiamusi and Jichin of 4.67 years. Liu, Y. (1983) reported that there were three overlapping periodicities of 3–5, 35–40, and 60–80 years in summer temperatures in Northeast China. He also divided cool summer years since 1878 into three groups : the first 1881–1918, the second 1934–1945, and the third 1956–1972.

Annual mean temperatures of the 70 years since 1911 were classified into five classes from the frequency of occurrence (AMSNBM, 1984). The first class, high temperature years, occurring below 12.5 percent, the second class 12.5–25.0 percent. The fifth class, low temperature years, occurring below 12.5 percent and

Table 7. Chronology of meteorological disasters in the Sanjian Plain

Year	Meteorological Data[1] at Fujing				Meteorological[2] Disaster					Remarks
	Jan. (°C)	Jul. (°C)	Precip. (mm)	Wind (m/sec)	Dr	Fl	Co	Fr	Wi	
1950	—	—	—	—						
1951	—	—	—	—			+			
1952	—	—	—	—						
1953	−22.1	21.1	527.8	12.7						
1954	−20.3	22.8	421.5	—			+			
1955	−18.1	22.8	533.4	15.0						
1956	−22.1	19.4	658.7	24.7						
1957	−17.6	21.4	732.4	16.7		+	++			
1958	−21.4	22.9	568.5	15.7			+			
1959	−21.1	19.7	824.5	17.0						
1960	−22.1	21.9	688.3	—		+	+			
1961	−21.1	22.2	411.3	14						
1962	−18.1	21.1	548.9	14						
1963	−19.1	21.7	563.1	16						
1964	−17.4	20.1	519.0	16			+			
1965	−19.7	20.7	651.9	18						
1966	−20.6	21.2	396.1	16			+			
1967	−18.0	22.1	378.8*	16	+					*Jiamusi 320 mm, Youyi 420 mm
1968	−19.7	22.5	547.2	14						
1969	−22.7	21.3	482.6	20			++			
1970	−23.2	23.2	366.6*	20	+					*Youyi 320 mm, Jiamusi 350 mm
1971	−18.9	19.9	674.1	—		+	+		+	Wind erosion at the 38th Group
1972	−19.3	22.6	618.9	18		+	++			
1973	−19.9	23.7	585.3	16		+				
1974	−18.4	22.8	532.5	19			+			
1975	−17.5	21.5	368.8	16	+					
1976	−17.9	23.2	410.2	21	+		+			
1977	−24.3	23.1	338.6	17.3	+					
1978	−21.7	22.9	412.5	17.7	++				+	Heavy wind damages twice at the 597th Farm
1979	−19.8	21.9	370.9	20.3					+	Strong wind on 6-9 May, Strong wind damages at Jiamusi and Luobei
1980	−22.9	22.6	504.7	15.3						
1981	−18.7	22.1	664.6	17.0		++				About 65% of total cultivated field were damaged by flood
1982	−19.4	23.9	495.6	17.0	+					
1983	−17.8	20.6	649.4	14.3						
1984	−21.4	22.1	678.8	12.0						
1985	−21.8	22.2	573.1	14.0		++				The heaviest floods in last 30 years

1) Jan. and Jul.: Monthly mean temperatures for January and July (°C), Precip.: Annual precipitation (mm), Wind: Annual maximum wind speed (m/sec).

2) Dr: Drought, Fl: Flood, Co: Cool weather, Fr: Frost, Wi: Strong wind.
+ : Disaster, ++ : Heavy disaster.

Table 8. Long term fluctuation of the dry-wet and cold-warm climate in the Sanjiang Plain (after DMCIGAS, 1981)

Period	Dry or Wet	Cold or Warm
1876—1885	Dry	Cold
1886—1894	Slightly Dry	Cold
1895—1907	Wet to Dry	Warm
1908—1917	Wet	Cold
1918—1930	Dry	Warm
1931—1941	Wet	Cold to Warm
1942—1954	Dry	Warm
1955—1965	Wet	Cold
1966—1978	Dry	Warm

Table 9. Cool weather damage after 1950 in Hokkaido

Year	Crop Situation Index	Type of Cool Summer Damage
1953	81	F I
1954	60	D G
1956	51	F I and D G
1964	68	D G
1965	86	F I
1966	73	F I
1969	86	F I and D G
1971	66	F I
1976	80	D G
1980	81	F I
1981	87	D G

FI: Floral impotency, DG: Delayed growth.

the forth class 12.5–25.0. And remaining are the third class. The power spectrum of the year to year change in the thermal index mentioned above was calculated by the maximum entropy method (Figure 4). In the spectrum, the maximum peaks are located at 5–6 years and 30–31 years. According to the fluctuation curve of annual temperature from 1882 to 1979 in Northeast China (Liu, Y. et al., 1983), there are three peaks in 1892, 1921. and 1948 of which are at roughly the same interval as the calculated ones.

—Frost—

The mean date of the first fall of hoar frost is during the last ten days of September in the plain, and the first date is during the first ten days of September. The mean date of the last fall of hoar frost is during the first ten days of May in the southwest of the plain and the middle ten days of May in the north

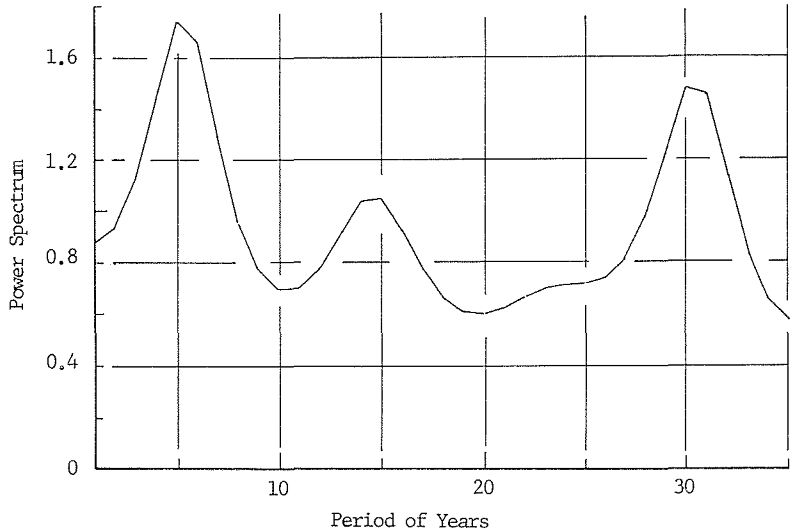

Figure 4. Power spectrum of the annual thermal index in Northeast China.

and south of the plain. The last dates with hoar frost are during the last ten days of May in the plain. The authors could not find any mention of frost injury in the reports and books consulted for this study. It is not clear whether there is little frost injury or frost injury is not clearly separated in statistical data in China.

c. Meteorological disasters due to precipitation

—Flood—

The Heilong R. has a large river basin, 890000 km^2 or 2.4 times the area of Japan. Floods in such rivers with large basins are generally classified into two types. One is caused by heavy rains or snow melting in the upper catchment of the river, the other is caused by heavy rains in or near the flooded area. It appears that the floods in this paper are of both types, but they can not be discriminated. There were rainfalls in the summer (June-September) of five years, 1911, 1915, 1932, 1934, and 1957 and very heavy ones during 1901 and 1960 in Northeast China (Zhang, X., et al., 1963), this coincides well with Table 8.

Youyi Farm in the central area of the plain suffered flood damages five times in the last 27 years (Liu, Z., 1984). The total crop production at the farm showed a 30 percent decrease in 1960 and a 35.7 percent decrease from 1971 to 1973. The heavy floods and drought affected the farm in 1981 and 1982, and total crop production through the two years showed a 48.4 percent decrease. The heaviest floods in the last thirty years occurred in 1985 (Photo 1). But the amount of annual precipitation at Fujin in 1985 is not extremely large compared with other years (Table 7). This means that the center of the heavy rains was away from Fujin or that the area of heavy rains was very wide. The true situation is not clear without more detailed data than that available in this report.

—Drought—

The Youyi Farm suffered drought damage nine times in the last thirty seven years (Photo 2), and seven years were free from floods and drought during this period. The drought in 1978 was very heavy and the total production of the farm decreased to 47.1 percent of a normal year. According to statistical data for the Hongxinglong Farm adjacent to Youyi Farm, the total area with drought damage in 1978 reached 205,000 hectares, corresponding to one fifth of the total cultivated area of Hokkaido. The wheat yield at the farm was only 510 kg/ha, and 23.6 percent of the cultivated area had zero yield (DMCIGAS, 1983). The 1978 precipitation at Fujin, about 80 km north northeast of Hongxinglong Farm, was 412.5 mm, not an extremely small value in the last thrity years. This appears to be caused by regional differences in precipitation, and meso-scale regional difference in precipitation will become more important in the study of drought in the Sanjiang Plain.

Periodicity of the year to year changes in annual precipitation at Fujin were confirmed by the spectrum analysis using the maximum entropy method. There is a highest peak at a period of 3 years and next peak at 10 years (Figure 5).

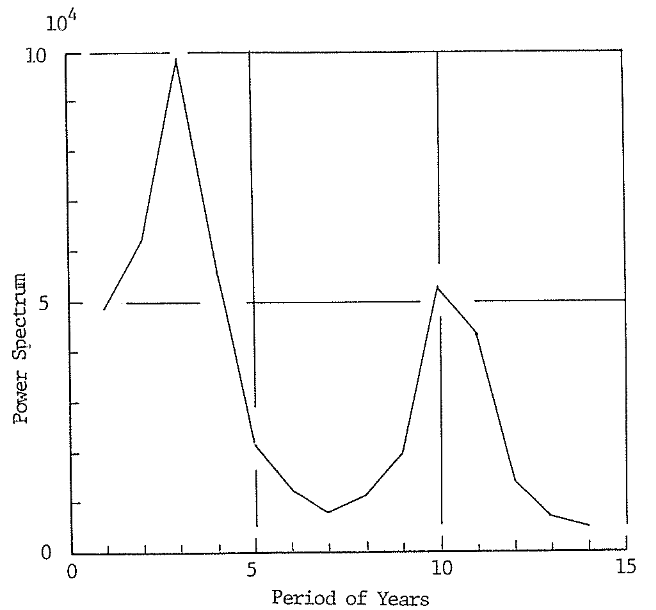

Figure 5. Power spectrum of annual precipitation at Fujin.

d. Meteorological disasters due to wind

Strong winds in spring are a climatic characteristic of the Sanjiang Plain. In China, wind erosions is generally caused when winds exceed 8 m/sec. Throughout the plain, except northern areas such as Fuyuan and Hegang, winds exceed 8 m/sec blow during more than 100 days a year, and in some localities more than 180 days

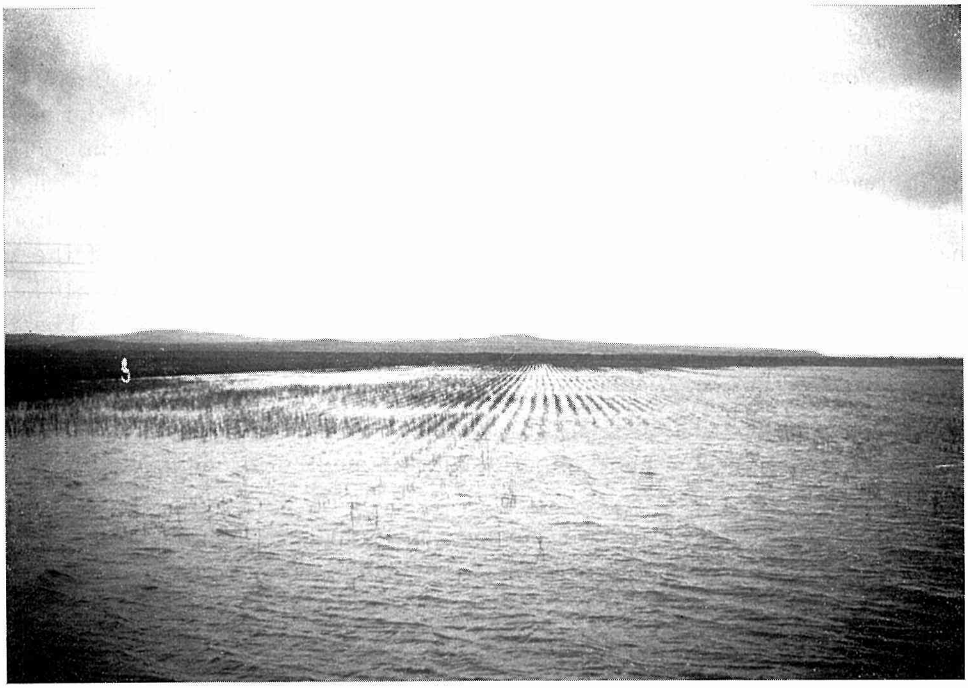

Photo 1. Flooding on a soybean field (taken by Takahashi near Jiansanjian on September 27, 1985).

Photo 2. The Sonhua River dried up (taken by Takahashi at Harbin on July 12, 1982).

annually. Dry weather with little rainfall in spring increases the potential for wind erosion in the plain.

Around 1950, the cultivated land area was only 3 percent of the total area of the Sanjiang Plain, the remaining was wasteland covered with grass and shrubs with many lakes, ponds, and bogs. Later, agricultural development advanced rapidly, and in 1979 a 36.1 percent of the land was under cultivation. Since 1962 about 8100 km^2 of forest has been cleared in the plain, reducing forested area from 29.9 percent to 23.9 percent. In Fujin county, forests have dropped from 15 percent in 1955 to 3 percent in 1981 (Liu, X., 1984). With the increases in uncovered and deforested areas with changes in land use, the area damaged by strong winds in the plain has increased annually. From 1949 to 1959, it averaged 26 km^2, increased to 51 km^2 the in 1960's, and 167 km in the 1970's. Since 1980, about 60 percent of the cultivated land has suffered some degree of damage from strong winds.

Lang, H. et al. (1983) reported detail of the strong wind damage occurring at the 38th Farm near Mishan in 1971. About 20 percent of the cultivated land of the farm had suffered damage. In the damaged areas, 66 hectares of young wheat seedlings and 81 percent of drainage channels were burried by brown sand, 111 hectares of leaves and stems of young wheat seedlings were damaged by strong winds and brown sand. On the basis of meteorological data at the 290th Farm about 30 km north of Fujin, Liu, X. (1984) reported that no wind damage occurred at the farm in the 1950's, but occurred 14 times in the 1960's, and 9 times in first two years of the 1970's. In May 1978, strong wind damage occurred twice at the 597th Farm located about 20 km northwest of Baoqing. One meter deep channels were burried in brown sand and about 20 cm deep brown sand accumulated around the windbreaks.

At the Baoquanling Farm about 20 km east of Hegang, very strong winds blew over the farm on 6–9 May 1979. As a result 1980 hectares land were denuded, wheat seedlings on 990 hectares were burried by brown sand, wheat roots on 6,600 hectares were exposed to air and leaves of young wheat plants on 13,860 hectares were injured by rapid desiccation.

5. Conclusion

The cultivated area in the Sanjiang Plain were only 3 percent of the total area in 1949. The remaining areas were covered with natural grass and shrubs, and there were many lakes, ponds, and bogs in the plain. Agricultural development was intensified in the last 30 years but since no adequate countermeasures against the meteorological disaster, were effected, the area damaged by meteorological disasters increased with the development.

The climate and meteorological disasters in the Sanjiang Plain were studied by comparing the plain and Hokkaido, Japan. The results are summarized as follows:
(1) Accumulated temperatures on the plain correspond to that of the east and north Hokkaido. But the frost free periods are somewhat shorter than in Hokkaido.
(2) Cool weather damage occurred twelve times during the last 36 years in the

Sanjiang Plain and eleven times in Hokkaido. The power spectrum analysis of the year to year change of the thermal idex in Northeast China showed a maximum peak at a period of 5-6 years and the next peak at 30-31 years.
(3) The year to year change in precipitation in the plain are relatively higher than that in Hokkaido. This points to the dangers of both drought and floods in the Sanjiang Plain.
(4) From the power spectrum analysis of the annual precipitation at Fujin, there is a maximum peak at a period of 3 years.
(5) Winds in the plain are strong in spring and autumn. There are some local winds in the plain.
(6) Despite no increases in wind speed, the area damaged by strong wind increased rapidly in the last twenty years. This is attributed to the increase of cultivated land with no windbreaks or shelterbelts.

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