A Change in the Weather:
An Assessment of Climate Change Vulnerability in China

Cynthia Ulbing
Ithaca College
Ithaca, New York

2013 Borlaug-Ruan International Intern
The World Food Prize Foundation
Chinese Academy of Agricultural Sciences
Beijing, China

Table of Contents

Acknowledgments

I would like to extend my deepest appreciation to the outstanding individuals who have worked to make this experience as exhilarating as it has been fulfilling. I am also extremely thankful for all the hard work that has been committed to ending hunger and providing education about food and agriculture to my generation.

The late **Dr. Norman Borlaug** has been such a heartening inspiration before and during my experience with the World Food Prize. His portrayal as a role model for aspiring agriculturalists and humanitarians will forever have its place in history.

Thank you so deeply to **The World Food Prize Foundation and its sponsors**, from whom I have seen such tremendous dedication. Two great leaders who stand out are **Lisa Fleming,** who has never failed to answer the phone in the middle of the night (merely 1 pm for me in China Standard time) and **Ambassador Quinn,** who has been such an amicable mentor and a phenomenal motivator. I would also like to provide recognition to **John Ruan III,** who is an excellent chairman for The World Food Prize and a sponsor for this internship and the foundation in general. I'd like to personally thank **Keegan Kautzky** and **Catherine Swoboda** for their endless devotion to The World Food Prize and working with youth across the world.

Thank you to my high school teacher **Patrick Brennan** for introducing me to The World Food Prize and for being an excellent supporter in my pursuing of this internship.

I would also like to thank the team from **The Chinese Academy of Agricultural Sciences** for being great friends and mentors. The wonderful **Dr. Ju Hui** for accepting me as an intern in her department, providing me with spectacular escapades, taking care of me while I was sick, and introducing me to **her family,** who welcomed me into their home every chance possible and taught me about Chinese culture. Thank you also to **Ms. Dongfang Pan** for making sure that I survived Beijing with a full stomach and sufficient bed rest. Of course, I would like to thank some of the many **friends** that I made overseas, including but not limited to **Xu, Huang, Jo and Wen.** I appreciate you treating me like part of your group and always making sure I had fun.

And a final thank you to **my family** back home, my **Mom, Dad, brother, sister, and beautiful little niece.** Skyping with you every day was the greatest cure for homesickness and I always looked forward to telling you about my adventures.

Thank you all. It's been fantastic.

CAAS Background

The Chinese Academy of Agricultural Sciences was founded in 1957 and is currently the largest Agricultural school in China in terms of researchers and facilities. It is affiliated with the Ministry of Agriculture of the People's Republic of China. The academy boasts 39 research institutes and one graduate school across the country, thirteen of which are based in Beijing ("State"). The campus in Beijing (where I was located) is in close proximity to Peking University and Chinese Agricultural University, allowing collaboration between the expert researchers who work at each.

Of CAAS's institutes, fifteen are related to crop research and industry, eleven are related to animal husbandry research, eight of them research in economic and environmental resources and five are related to agricultural engineering ("About").

CAAS also contains four "National Key Laboratories." These laboratories receive administrative support from the government of the People's Republic of China. The government chooses different labs across the nation that specify in areas of academic interest and provides the funding necessary to the universities that house them ("State").

IEDA CAAS

I was honored to be the first Borlaug-Ruan Intern at CAAS to work in the Institute of Agro-Environmental and Sustainable Development. This is home to most of the environmental science departments at CAAS, as well as the meteorology department.

I was working under the direction of Dr. Ju Hui in her department concerning climate change. Dr. Ju Hui is a brilliant scientist who has been working to combat the effects of climate change for years and is currently supervising multiple relevant projects. My collaboration with her turned out to be relatively efficient considering her lack of experience with foreign high school interns.

Abstract on Research

Upon my arrival at CAAS I was scheduled to meet with Dr. Ju Hui to determine which project that I would be working on. It was determined in this meeting that I would be contributing to her ongoing acquisition of assessing climate change vulnerability throughout China in order to better counteract its effects.

Although this sounds like a simple concept, current methods of assessing vulnerability still contain a lot of uncertainty. It is something that the Climate Change Department is constantly working on, and my mentor was confident that an outside perspective would help the team draw fresh conclusions.

The basis of our study was: If the Climate Change Department becomes better able to assess the vulnerability of farmers to the changing climate then they will be able to develop more advanced methods to adapt to these changes. By isolating key factors effecting vulnerability, applied methods can be more precise and therefore more effective in maintaining (or increasing) crop yields and nutrition quality.

China has been forced to maintain 20% of the world's population on 10% of the global farmland ("About"). Due to this issue, it is vital that China be able to sustain a healthy food supply. A decline in food production could create a ripple effect that would even further threaten the food security of the entire world.

Most of my work was research-based. During the first half of my internship I worked to interpret international journals and research geographical conditions in China, as well as recent policies the government has put into place to help the country adapt to climate change. I was also able to spend a limited amount of time in the field to witness these conditions first-hand.

The second half of my internship was spent working on my vulnerability assessment. This required charting multiple variables that effected climate change vulnerability in each of the Chinese provinces. This part of my research was much more active and integrated with the rest of the Climate Change Department.

Ultimately my research was successful in providing climate change vulnerability assessments. This information will be processed by the team at CAAS in future work, and will be an appropriate contribution to my department.

Agriculture in China

China is the number one food producer in the world, sustaining one fifth of the earth's population. In keeping that they need to sustain these people in an area smaller than Canada, the demand for agriculture is high. Still, the country has one of the lowest areas of cultivated land per capita (only 0.11 hectare/head) in the world and the number of people employed in agriculture is on the decline. While 49.1% of China's population was employed in agriculture in 2002, a 2011 survey revealed that only 34.8% remained ("Employment") (also, more than half of this workforce is made up by women ("Impact of International")). While that statistic still includes almost 465 million people, it is questionable whether this is enough to sustain the (still gradually increasing) population.

Agriculture has also seen a decline in its role in China's Gross Domestic Product. While in 1983 it produced 33% of the country's GDP, in 2011 it was responsible for less than 12% ("Agriculture, Value added").

So what is causing the decline in agriculture? There are a lot of possibilities. One source suggests that the stress put on women to work in agriculture and still sustain their role as housewives may be too much in some areas. Some have had to give up their jobs in favor of raising their families ("Impact of International"). Another factor may be the ever increasing industry in China drawing workers out of the fields and into the cities where jobs are more prominent, cut and dry, and require less days slaving out in the hot fields. While all these factors may be linked to the decline in agriculture, there is one major issue that cannot be ignored- China's extreme liability to the changing climate.

According to the Environmental Vulnerability Index created in 2004 (Appendix A), China ranks as one of the most vulnerable countries to climate change. Over the past few years this has proven to be true. The National Meteorological Centre has responded to more floods and droughts annually than it has in fifty years. This instance is leading to increased crop failures. It is estimated that the grain loss due to drought has reached 37.3 million tonnes annually since 2000 (Branigan). In 2009, an estimated 29.3 million hectares of farmland suffered from drought, leading to the reduced ability of nearly 11 million livestock to have access to water (Wang). The Yangtze, the third largest river in the world, is drying up, threatening not only farmers who use it for irrigation, but the entire population, which relies on it for 40% of their hydropower capacity (Polycarpou). As if the devastation in agriculture wasn't enough, it seems like every year China has to face mass deaths caused by typhoons, drought and, most predominantly, flooding. This past July, 44 were left dead and 100,000 had to evacuate their homes after a major flood in the Sichuan province ("China Floods").

Between the crop failures and the death tolls, it is obvious something needs to be done. China's leading agricultural departments have been developing new technologies and policies to combat climate change not only in China, but worldwide. In 2012 The [Chinese] National Development and Reform Commission published a 29-page paper titled, "China's Policies and Actions for Addressing Climate Change." Here are some excerpts from that paper worth declaring:

- "In 2011, The General Administration of Quality Supervision, Inspection and Quarantine and the National Development and Reform Commission set 28 national standards on energy-consumption."

- "In 2011, the country distributed more than 18.26 million high-efficiency air conditioners, 150 million energy-saving lamps and more than 4 million energy-efficient motor vehicles."

- "The Ministry of Agriculture has invested 4.3 billion Yuan, directing local governments to encourage the use of methane gas. In 2011, a total of 41 million households were using methane, cutting CO2 emissions by 60 million tons."

- "[The National Development and Reform Commission] has calculated and defined overall caps for greenhouse gas emissions in their regions, and formulated plans for distributing specific emissions targets."

- China's National Development and Reform Commission…signed the Memorandum of Understanding on Providing Foreign Aid to Address Climate Change with Ethiopia, Grenada, Nigeria, Madagascar, and Benin, promising to donate energy-saving and low-carbon products to these countries. It has also successfully arranged eight seminars on addressing climate change in developing countries, which offers training to more than 300 officials and professionals from 81 countries."

These are only a few of the many policies that have been put into place. While these policies are fundamental to reducing China's carbon footprint, they are not as a whole capable of mollifying the impact of environmental changes on the agricultural sector.

<u>What Makes up Chinese Agriculture?</u>

The number one crop in China is rice, taking up about 25% of the cultivated landmass. Rice harvesting has become quite popular in the south, where the longer summers create more ideal conditions. Rice cultivation is especially labor intensive, requiring hours of work to transplant seedlings, as well as to harvest the crops ("Rice").

Wheat is the second most abundant crop, becoming a staple in the typical Chinese diet where it is eaten in the forms of steamed breads and noodles. Wheat is grown throughout China but thrives especially well in the North (Hays).

Other major food crops grown in China include peanuts, tubers, soybeans and corn. Peanuts are commonly grown in the southern and eastern portions of China, tubers in the south and west, soybeans in the east and corn throughout (Hays).

Due to a high demand, about 75% of cultivated land in China is reserved for food crops. A need for non-food crops, however, is on the rise. Under the conditions that they maintain food security (something that is already a bit of a struggle in rural areas), China intends on producing more crops for the conversion into bio-fuels. Officials claim that there is nearly 100 million hectares of barren land suitable for conversion to bio-fuel crops, including long-preserved grain and the most common bio-fuel crop-- maize (“China to Produce”). Other major cash crops include cotton and tobacco (Hays).

<u>China’s Climate</u>

China can be geographically divided into five basic regions- North China, South China, East China, West China and Central China. Each of these regions differs in climate and environmental features (“China Climate by Region”).

East China refers mainly to the provinces and regions bordering the Pacific Ocean. This area’s climate is greatly influenced by oceanic patterns and is seasonally affected by typhoons and ocean currents. The area is alternately affected by monsoons from the continent. This leads to rain and humidity in the summer and cold, dry winters. Rainfall is most abundant in the late summer leading into fall. This rainy season counters many of the negative effects caused by the harsh weather, making East China one of the most arable parts of the country.

South China is the hottest area in China and is part of the subtropical zone. Precipitation is heaviest in the summer, but winters are wet as temperatures usually stay above freezing. Snow is highly uncommon. The area is hit by tropical, sub-tropical and equatorial monsoons in the summer. The warm, wet climate makes South China excellent for growing rice, though changing climate conditions have had numerous effects on southern rice production (Xiong). Sugarcane is also a common food crop ("China Climate by Region").

Climate conditions in West China may be the harshest among the five. Rain from the annual monsoons does not reach to West China, and the long summer days make much of the land dry and not arable. The temperature differences between day and nighttime are significant and while the summer months usually average above 30 degrees Celsius, the winters usually stay below 0. While these conditions make any agricultural advances difficult in this area, China is working on developing an agricultural sector in the West. There is currently limited success in growing certain tuber plants and there are hopes to install sugarcane, cotton, tropical plants and a few other species ("China Climate by Region").

Central China has the most variations of any area in China, well representing all four seasons. The area is affected by moderate rainfall in the summer, high rainfall in the spring, and light to moderate snowfall in the winter. Different annual monsoons bring this weather to Central China where the effects are not overly drastic. Central China is home to a variety of crops such as rice and winter wheat, as well as populous with numerous types of livestock and the location of many other productions, such as the raising of silkworms.

North China is the coldest area in China, with temperatures that drop below 20 degrees Celsius in winter, and the northernmost areas never getting above 30 in the summer. Despite the cooler temperatures, North China is home to many crops including rice, wheat, oats, and other food and fiber crops ("Agricultural Development").

Vulnerability in the Agricultural Sector

As previously mentioned, the changing climate shows high threats to Chinese agriculture. Over the course of one hundred years, the annual mean surface temperature has raised 0.8-1.8 degrees Celsius. This has had various effects on the agricultural sector. On one hand, crop seasons have been prolonged and there has been a decrease in cold damages in Northeast China. On the other hand, many agricultural technologies are losing their advantage and irrigation has become more difficult due to increased evapotranspiration (Wang). While the currently implemented policies do much to alleviate these threats, further assessment is necessary to determine what can be done to abate hardships on a more individual level for those involved in Chinese agriculture. This is why vulnerability assessments are fundamental before issues can be fully addressed.

What is Vulnerability?

Determining *what* exactly vulnerability is can be tricky. While the term "vulnerability" can be simply defined as "open to attack or damage," when it is placed in relativity to climate change it refers to a lot of deeper aspects ("Vulnerable").

Vulnerability in regards to climate change has been defined in multiple conducts over the past years. In 2001 the International Panel for Climate Change (IPCC) created the standard definition of climate change vulnerability. They stated that vulnerability is dependant on three main factors- exposure, sensitivity and adaptive capacity. The IPCC definition can be expressed through the formula vulnerability= f (e,s,a). In this formula, let e be an area's exposure to climate change, let s be the area's sensitivity to climate change, and let a be the area's adaptive capacity to climate change. Exposure and sensitivity are directly related to vulnerability, where when one or both of said factors are increased the level of vulnerability is increased. Adaptive capacity, on the other hand is inversely related, where when adaptive capacity is increased the vulnerability level is decreased ("Adaptation and Mitigation").

For the sake of this report, the IPCC definition of vulnerability will be utilized. This classification is widely accepted and has been used in the majority of vulnerability reports in the past 12 years. Many respectable reports pertaining to Chinese agricultural vulnerability use this definition, such as the recently published Volume 23 Issue 1 report from Chinese Geographical Science, "Assessing Vulnerability to Drought based on Exposure, Sensitivity and Adaptive Capacity: A Case Study in Middle Inner Mongolia of China" (Liu).

Still, the IPCC definition is not unchallenged or unaltered. There is still a lot of room to define what exactly justifies exposure, sensitivity and adaptive capacity and what indicators should be connected to these components. This is where there is room for expansion by the researcher. I personally chose specific indicators that I have found to be valid and relevant to the issue of climate change in China.

Where to Assess

For this report I chose to assess the individual Chinese provinces, municipalities and autonomous districts. This totals to 31 different zones. For the sake of this report the areas of Hong Kong, Macau and Taiwan are not considered Chinese provinces (due to debate and a general lack of information available). Using these predetermined boundaries made information retrieval more fluid and makes the assessment more comprehensible. It is not unrealistic, however, for an assessment to be based on other geological factors such as climate zones, land types, or designated areas that are more uniform in size.

The Method, the Components and the Indicators

As aforementioned, the three components of vulnerability include exposure, sensitivity and adaptive capacity. I choose to display these components using a graphing system referred to as Iyengar and Sudarshan's method. This method was developed in 1982 with the purpose of ranking districts based on their economic performance, but was later edited in the report "Quantitative assessment of Vulnerability to Climate Change" to mathematically display climate change vulnerability ("Quantitative").

Unfortunately, I was unable to properly weigh the factors or give them each exact values due to lack of advanced programming, expert knowledge, or professional help. Still, I believe my graphs provide an accurate representation of vulnerability to climate change on the provincial level.

The indicators I used for each component are as follows:

Exposure:
E1- *Percentage change in rainfall from base year (1960-1990, 1990-2009)*
E2- *Change in maximum temperature*
E3- *Change in minimum temperature* ("Knowledge Portal")

Sensitivity:
S1- *Cultivated land (ha)* (Li)
S2- *Percentage of gross area irrigated to gross area cultivated* ("Global Map of Irrigation"), (Li)
S3- *Density of livestock population per km2* ("Livestock Population")
S4- *Density of population per km2* ("Chinese Province Table")

Adaptive Capacity:
A1- *Literacy rate* ("Illiteracy")
A2- *Unemployment Rate* ("Unemployed People in China")
A3- *Percentage of land urbanized* ("Chinese Province Table")
A4- *GDP per capita (CN)* ("GDP")

The following table represents my findings:

		Exposure			Sensitivity				Adaptive Capacity			
Provincial-Level Division (GB Code)	**Provincial-Level Divisions (English Names)**	**E1**	**E2**	**E3**	**S1**	**S2**	**S3**	**S4**	**A1**	**A2**	**A3**	**A4**
BJ	**Beijing Municipality**	-73.19	-1.44	2	529534	64	1917	1,167.40	98.3	0.41	85	87091
TJ	**Tianjin Municipality**	-79.61	-0.75	1	659849	52	1757	1,144.46	97.9	1.55	76	93110
HE	**Hebei Province**	-60.19	-5.65	8	7472837	60	2296	382.81	97.39	0.5	40	36584
SX	**Shanxi Province**	-122.6	0.25	1	5071120	22	432	228.48	97.87	0.59	44	33628
NM	**Inner Mongolia Autonomous Region**	-46.5	0.52	-5	8153086	29	88	20.88	95.93	0.88	50	64319
LN	**Liaoning Province**	-69.64	0.59	1	4374632	33	2408	299.83	98.07	0.9	59	56547
JL	**Jilin Province**	5.25	1.55	-1	5767082	23	1049	146.54	98.08	0.81	53	43412
HL	**Heilongjiang Province**	-65.63	-39.1	-2	11876789	17	331	84.38	97.94	0.91	54	35711
SH	**Shanghai Municipality**	1.69	-0.54	-0.5	270400	95	2223	3,630.20	97.26	1.17	89	85033
JS	**Jiangsu Province**	-44.25	0.12	1	5506193	71	3037	766.66	96.19	0.53	53	68347
ZJ	**Zhejiang Province**	88.91	1.01	1	2558064	55	1231	533.59	94.38	0.58	10	63266
AH	**Anhui Province**	7.32	0.54	0.5	5712049	56	1564	425.91	91.66	0.56	39	28792
FJ	**Fujian Province**	146.1	0.23	1	1549557	61	939	304.15	97.56	0.4	49	52763
JX	**Jiangxi Province**	118.6	0.13	1	3119723	61	1042	266.87	96.87	0.55	40	28799
SD	**Shandong Province**	-98.31	0.9	-0.5	8238204	59	3535	622.84	95.03	0.47	47	51768
HA	**Henan Province**	-61.14	0.43	0.5	8086027	58	3795	563.01	95.75	0.41	34	31723
HB	**Hubei Province**	-98.98	0.13	-0.5	4750732	44	1442	307.89	95.42	0.96	44	38574
HN	**Hunan Province**	3.23	-0.39	1	3941023	68	1473	312.77	97.33	0.66	40	33480
GD	**Guangdong Province**	282.8	-0.48	-1.2	4589338	32	1979	579.46	98.04	0.37	63	54096
GX	**Guangxi Zhuang Autonomous Region**	169.8	-0.13	0.55	4326503	35	1225	195.02	97.29	0.41	36	27943
HI	**Hainan Province**	189.2	1.3	1.5	867152	21	1129	255.04	95.92	0.33	47	32375
CQ	**Chongqing Municipality**	-101.8	0.59	1	2365386	26	1324	350.5	95.7	0.45	48	39083
SC	**Sichuan Province**	-64.04	0.78	-1	6192201	40	1061	165.81	94.56	0.46	36	29579
GZ	**Guizhou**	66.31	0.34	0.8	4482294	15	489	197.42	91.26	0.36	25	19566

	Province											
YN	**Yunnan Province**	72.04	0.98	3	7032835	20	381	116.66	93.97	0.35	32	22196
XZ	**Tibet Autonomous Region**	-72.57	-0.48	0.07	232000	67	20	2.44	62.63	0.33	28	22936
SN	**Shaanxi Province**	-70.11	0	0.14	5188506	25	382	181.55	96.26	0.56	41	38557
GS	**Gansu Province**	-34.65	1.21	-1	5063900	19	127	56.29	91.31	0.42	32	21978
QH	**Qinghai Province**	-8.46	3.1	-2.5	759607	28	30	7.8	89.77	0.78	40	33023
NX	**Ningxia Hui Autonomous Region**	-34.38	3.07	-2.3	1268800	31	194	94.89	93.78	0.84	44	36166
XJ	**Xinjiang Uyghur Autonomous Region**	8.33	-0.89	2.58	5104320	61	41	13.13	97.64	0.51	39	33909

Compiling this information was probably the most tedious part of my research, taking up a good portion of my time spent on this project. While some of the information (for example the percentage of land urbanized) was readily available, many variables needed further research and had to be compiled in pieces, means and/or sums calculated and then recorded. Some examples lie in E1, E2, and E3, where the monthly totals had to be recorded from an interactive map, then the annual means found and compared. The graphical representation I have provided for each province is located in Appendix B. The benefit of this method is that by compiling multiple years into each timeframe, it eliminates the possibility of a single “bad year” for a province creating misinformation in the overall result.

A noteworthy issue relating to rainfall levels is that scientists have yet to record any specific trend that can be linked to climate change. Due to a high tendency for precipitation levels in China to fluctuate about every 20 years, no specific threat has been recorded thus far. Still, the number of rainless days has been increasing at a rate of four days per decade since 1958 (Wang). There is also limited uncertainty regarding the land irrigated in China, according to the Food and Agriculture Organization. While this is a slight issue, I have used what is considered by CAAS to be the most reliable information available.

One surprise I encountered when compiling this information was the large variation in livestock density. At first I thought that I must have made some sort of error in my calculations, but upon checking and rechecking the data available and my math, I determined that the above information is, in fact, correct. While some districts contain a very high density of livestock per km2, other districts had numbers incredibly low. I believe this is more directly related to the geographical size of each district (i.e. Inner Mongolia may have its livestock spread over more area) than the prominence of farming.

The Final Step- Determining Vulnerability

After the long drawn-out process of collecting this information, I had finally reached the final step of calculating the vulnerability ranking for each province. Due to my inability to appropriately weigh the indicators, I simply gave each province a ranking comparatively to the other provinces. This was done under each indicator displaying an order from lowest to highest. In situations where two provinces may have the same number, the same ranking was provided. While there is still some limited variability in the results as a consequence of this, the overall rankings are considered to be accurate displays of each province's total vulnerability.

An important factor to keep in mind during these rankings is the indicator's relationship with overall vulnerability. While some ranks seem to be "backwards," ranking from highest to lowest, this is a result with the indicator's relationship. While the components as a whole show a direct or inverse relationship, different indicators can have specifically direct or inverse relationships with vulnerability. This is based on phrasing and how the numbers are determined.

An example of this is how a higher percentage of irrigated land to total cultivated land is related to sensitivity, but would lead to an overall decrease in vulnerability (even though sensitivity shows a direct relationship with vulnerability). Conversely, a higher unemployment rate would lead to an overall increased vulnerability despite the fact that adaptive capacity and vulnerability share an inverse relationship.

The relationships between indicators vulnerability are portrayed in the following table:

E1	E2	E3	S1	S2	S3	S4	A1	A2	A3	A4
Increase	Increase	Increase	Increase	Decrease	Increase	Increase	Decrease	Increase	Decrease	Decrease

Finally, the rankings for each province and their final vulnerability rankings are as follows:

		Exposure			Sensitivity				Adaptive Capacity					
Provincial-Level Code (GB Code)	**Provincial-Level Divisions (English Names)**	**E1**	**E2**	**E3**	**S1**	**S2**	**S3**	**S4**	**A1**	**A2**	**A3**	**A4**	**Total**	**RANKING**
BJ	**Beijing Municipality**	20	21	9	3	5	24	30	1	6	2	2	123	**23**
TJ	**Tianjin Municipality**	21	13	6	4	12	23	29	6	27	3	1	145	**17**
HE	**Hebei Province**	11	25	8	27	7	27	22	10	11	14	15	177	**4**
SX	**Shanxi Province**	27	5	6	19	24	10	14	7	17	12	19	160	**11**
NM	**Inner Mongolia Autonomous Region**	10	10	5	29	19	4	4	17	22	8	5	133	**22**
LN	**Liaoning Province**	16	12	6	14	16	28	17	3	23	5	7	147	**16**
JL	**Jilin Province**	3	22	6	24	23	14	9	2	20	7	11	141	**18**
HL	**Heilongjiang Province**	14	26	9	31	28	7	6	5	24	6	17	173	**6**
SH	**Shanghai Municipality**	1	11	3	2	1	26	31	13	26	1	3	118	**24**
JS	**Jiangsu Province**	9	2	6	22	2	29	28	16	13	7	4	138	**20**
ZJ	**Zhejiang Province**	22	18	6	10	11	18	24	24	16	21	6	176	**5**
AH	**Anhui Province**	4	11	3	23	10	22	23	27	15	15	26	179	**3**
FJ	**Fujian Province**	28	4	6	8	6	12	18	9	5	9	9	114	**27**
JX	**Jiangxi Province**	26	3	6	11	6	13	16	14	14	14	25	148	**15**
SD	**Shandong Province**	23	16	3	30	8	30	27	22	10	11	10	190	**1**
HA	**Henan Province**	12	8	3	28	9	31	25	19	6	17	21	179	**3**
HB	**Hubei Province**	24	3	3	17	13	20	19	21	25	12	13	170	**8**
HN	**Hunan Province**	2	7	6	12	3	21	20	11	18	14	20	134	**21**
GD	**Guangdong Province**	31	9	7	16	17	25	26	4	4	4	8	151	**14**
GX	**Guangxi Zhuang Autonomous Region**	29	3	4	13	15	17	12	12	6	16	27	154	**12**
HI	**Hainan Province**	30	20	15	6	25	16	15	18	1	11	22	179	**3**
CQ	**Chongqing Municipality**	25	12	6	9	21	19	21	20	8	10	12	163	**10**
SC	**Sichuan Province**	13	14	6	25	14	15	10	23	9	16	24	169	**9**
GZ	**Guizhou Province**	15	6	14	15	29	11	13	29	3	20	31	186	**2**
YN	**Yunnan Province**	18	17	13	26	26	8	8	25	2	18	29	190	**1**
XZ	**Tibet Autonomous Region**	19	9	1	1	4	1	1	31	1	19	28	115	**26**
SN	**Shaanxi Province**	17	1	2	21	22	9	11	15	15	13	14	140	**19**

GS	**Gansu Province**	8	19	6	18	27	5	5	28	7	18	30	171	**7**
QH	**Qinghai Province**	6	24	11	5	20	2	2	30	19	14	21	154	**12**
NX	**Ningxia Hui Autonomous Region**	7	23	10	7	18	6	7	26	21	12	16	153	**13**
XJ	**Xinjiang Uyghur Autonomous Region**	5	15	12	20	6	3	3	8	12	15	18	117	**25**

As displayed in the table, the provinces with the highest vulnerability rankings are the Yunnan Province and the Shandong Province. This result is in accordance with previous research conducted at CAAS. The drying of reservoirs in the Yunnan province during their “Three Year Drought” has effected over six billion people (Joel). The following were some of the most effective pictures I was shown during my internship at CAAS, provided to me by Dr. Ju Hui.

PHOTOS PROVIDED BY CAAS

Dr. Norman Borlaug once famously said “Food is the moral right of all who are born into this world.” (“Dr. Norman E. Borlaug”). The eight weeks I spent in Beijing truly fulfilled my understanding of this quote.

During my stay I interacted with people who grew up in the smallest villages in Tanzania and people who spent their whole lives in the vast city of Beijing. There are few things that can be said about every individual who breathes air on this earth, but one is that nobody should have to go to bed hungry. We live in the age of plenty. We live in an age where the power belongs to the people more than it ever has before. We are living in the age of change, and I foresee a future where the ugly plague of hunger won't show its face on every street corner. Where children everywhere won't have to experience the null prolonging pain of an empty stomach.

The future is in the hands of my generation, and I will always be the optimist. I would like to once again thank The World Food Prize for showing me the faces of fellow hunger fighters all across the world.

Hats off to the optimists.

Personal Experience

One of my favorite parts of J.R.R. Tolkien's *The Fellowship of the Ring* is when Samwise Gamgee stops at the edge of a field and tells Frodo, "This is it. If I take one more step, it'll be the farthest away from home I've ever been."

This is precisely how I felt as I boarded the plane to Beijing. Sure, I was technically still in Detroit, but I had reached the point of no return. I had no idea how to feel. I was thrilled to be embarking on a tremendous adventure, but it took every bit of courage that I had.

After a thirteen hour plane ride I touched down in the international hub of China. The first person I met was the boy holding my name card in the airport. He told me his name was Xu, but I could call him Jerry (I stuck with Xu, he didn't look much like a Jerry). Xu was only a couple years older than me and also worked under Dr. Ju Hui at CAAS. He would continue to be my closest friend during my stay in China, showing me all the local shops and bakeries and teaching me tidbits about Chinese culture.

I was very lucky with my room assignment. Although the "apartments" (more similar to dormitories in America) were made for two people, I got my room all to myself. I had two beds, two desks, a tv, a wardrobe, a mini fridge, a water cooler, a small balcony and a bathroom. The water cooler was replaced twice weekly at my discretion and was my main source of drinking water, as tap water in Beijing is tainted. The balcony was for hanging my clothes to dry after I washed them- an old tradition in China that has been reenacted in the age of saving energy.

It took about a week after touching down in China for the butterflies in my stomach to go away, but if it didn't push me out of my comfort zone a little then it wouldn't be a learning experience. Coming from a small town in Upstate New York, the immense size of Beijing was startling to me.

As a foreigner to one of the world's largest cities, a good amount of my time was dedicated to sightseeing. There were so many places that I needed to see in and around the city, and my spectacular friends and mentors made sure I saw them all. Although my friends teased me for being the "stereotypical tourist," I found that most of them were pretty excited to take me places and teach me about their history.

I could write a whole essay just about my experiences sightseeing, but a couple monumental places I had the honor of visiting include The Great Wall, The Forbidden City and the Hutongs, or traditional courtyard residences.


A photo of me during my visit to The Forbidden City

When I wasn't out sightseeing I *was* pretty excited to experience civilian life. I took advantage of the opportunities I had to explore CAAS's campus and I left the campus with a mentor every chance I got. Through some intentional and some unintentional circumstances I had the opportunity to interact with Chinese banks, post offices, malls, bakeries, restaurants, hospitals, trains, buses and taxi cabs. Each of these encounters was a fantastic opportunity to learn more about typical daily life in China as well as practice my interaction skills with people who speak different languages.

Although the International Student Apartments had a cafeteria that I occasionally utilized, I was more inclined to join Dr. Ju Hui on her weekly shopping trips. The small fridge and toaster in my room allowed me to accommodate for a certain amount of groceries each week. I soon became familiar with the smaller local markets that sold traditional Chinese foods and the larger import stores that had international ingredients (most commonly German or Australian).

By the end of my trip I was pretty comfortable with (real) Chinese food. I lived by my motto that "I'll try anything twice" and experimented with a plethora of different foods. Despite my desire to develop a more international taste, I found that most of the foods I enjoyed were not too far different from American-style dishes. One of my favorite dishes was the beef noodles with bok choy.

The biggest difference I saw between Chinese and American dining was in the nutrition quality of the dishes. Even when I ate fast food in China, each dish came with at least one full serving of vegetables. Many of the foods that would have typically been fried in America were steamed in China. This was a sacrifice that I was more than happy to make, but I found a much deeper meaning in it. For the average American food is in abundance. We are surrounded by it so we choose our meals based on what we *want.* In China, meals are formed around what people *need.* Even in an international city like Beijing, malnutrition is a serious threat and mealtime is an opportunity to nourish your body, not just feed your stomach. This reflects the ever-looming threat of hunger in a still-developing country.

My least enjoyable meal in Beijing was served to me on an evening when I went out with my friend Jo and some of his friends from college. The boys took me to a small one-room restaurant on a side street in the center of the city. Outside a man grilled lamb on a barbeque and behind the counter huge metal pots held boiling liquid. Jo insisted on ordering for me and I agreed me I could not know what I was eating until after I'd tried it. In a couple minutes a server set down a large bowl of what was obviously intestines in front of me. I gave Jo a disapproving look. *Do you really think that I don't know what intestines look like?* Still, I promised that I would try them and I did. They were pork intestines and to be honest, they weren't that bad tasting. I admire the Chinese people for utilizing the entirety of an animal, but the texture and the concept took away my appetite. I didn't finish my dish, and I don't intend on trying them again anytime soon.

Another amusing dining experience I had was during the first dinner that I shared with Dr. Ju Hui and her family. I was introduced to the entirety of her extended family who had invited me to their home for an American-style dinner. The women weren't terribly familiar with preparing American food, but they denied any help that I offered. People my age do not do kitchen work in China (little did they know how I work in the food industry back home). The meal they provided consisted of watermelon, sushi, pizza, bread, lemonade and a "salad." They were excited for me to teach them how to eat everything with a knife and a fork.

The dinner was great for the most part, but the recipe for an American-style salad must have gotten lost in translation. The salad was a fruit salad, which is great, but was covered in a mixture of Ranch and Thousand Island salad dressing. The result was quite an interesting concoction, but everybody seemed to be enjoying it so I didn't bother correcting them.

One of the biggest questions I receive now that I am back home is: "How has this experience changed you?" To be honest, I'm not quite sure how to phrase exactly *how* my experience changed me, but I can say for sure that it has. Every day when I wake up I look at the world differently. Everything is so much more *extraordinary.* I have grown so much over the course of my journey and become so much more self-reliant. I trust the people of my generation worldwide to care about the future and to make a difference in the world. On a profound level I trust *myself* to take great risks and go on grand adventures with a new level of courage and worldly understanding.

It's like Frodo told Sam, "Come on, Sam. Remember what Bilbo used to say: 'It's a dangerous business, Frodo, going out your door. You step onto the road, and if you don't keep your feet, there's no knowing where you might be swept off to."

Works Cited

"About CAAS." *At a Glance_Chinese Academy of Agricultural Sciences*. Chinese Academy of Agricultural Sciences, 2013. Web. 1 Oct. 2013.

"Adaptation and Mitigation." *Know.climateofconcern.org*. Know Climate Change, 2013. Web. 1 Oct. 2013.

"Agricultural Development in the North China Plain." *Worldbank.org*. Independent Evaluation Group- The World Bank, 2012. Web. 1 Oct. 2013.

"Agriculture, Value Added (% of GDP)." *Worldbank.org*. World Bank, 2012. Web. 1 Oct. 2013.

Branigan, Tania. "Droughts and Floods Threaten China's Economic Growth, Forecaster Warns." *The Guardian*. N.p., 30 June 2009. Web. 31 Oct. 2013.

"China Climate by Region." Great Wall Discovery, 2009. Web. 1 Oct. 2013.

"China Floods Death Toll Rises." *The Guardian*. Associated Press in Beijing, 11 July 2013. Web. 1 Oct. 2013.

"China to Produce Liquid Bio-fuel with Non-food Crops." *Gov.cn*. Ed. Yao Siyan. N.p., 4 Sept. 2007. Web. 1 Oct. 2013.

"China's Policies and Actions for Addressing Climate Change." *Ccchina.gov.cn*. The National Development and Reform Commission The People's Republic of China, 2012. Web. 1 Oct. 2013.

"Chinese Province Table." *China's Province Table*. Society for Anglo-Chinese Understanding, 2009. Web. 1 Oct. 2013.

"Climate Change Knowledge Portal 2.0." *Climate Change Knowledge Portal 2.0*. Worldbank, 2013. Web. 1 Oct. 2013.

"Distribution of the Workforce across Economic Sectors in China 2012." *Statista RSS*. Statista, May 2013. Web. 1 Oct. 2013.

"Dr. Norman E. Borlaug to Celebrate 95th Birthday on March 25th." *Worldfoodprize.org*. The World Food Prize Foundation, 4 Mar. 2009. Web. 1 Oct. 2013.

"Employment in Agriculture (% of Total Employment)." *Worldbank.org*. World Bank, 2012. Web. 1 Oct. 2013.

"GDP per Capita (current US$)." *Worldbank.org*. The World Bank, 2012. Web. 1 Oct. 2013.

“Global Map of Irrigation Areas." *FAO*. AQUASTAT, n.d. Web. 1 Oct. 2013.

Hays, Jeffrey. "Crops in China: Grain, Imports, Exports and GM Crops." *Facts and Details*. N.p., 2008. Web. 1 Oct. 2013.

"Illiteracy Rate in China in 2011, by Province." *Statista RSS*. Statista, Oct. 2012. Web. 1 Oct. 2013.

"Impact of International Agricultural trade and Gender Equity: Selected Country Case Studies."*FAO.org*. FAO Corporate Document Repository, n.d. Web. 1 Oct. 2013.

Joel. "Yunnan’s “Three Year Drought” Drying Up Vital Reservoirs." *ChinaSMACK*. N.p., 22 Feb. 2012. Web. 1 Oct. 2013.

LI, Xiubin, and Xiuhong WANG. "Changes in Agricultural Land Use in China." Institute of Geographical Sciences and Natural Resources Research Chinese Academy of Sciences, 2003. Web. 1 Oct. 2013

LIU, Xiaoquian, Yanglin WANG, Jian PENG, Ademola K. BRAIMOH, and He YIN. "Assessing Vulnerability to Drought Based on Exposure Sensitivity and Adaptive Capacity: A Case Study in Inner Mongolia of China." Science Press, 18 Apr. 2012. Web. 1 Oct. 2013.

"Livestock Population (GLiPHA)." *Data.FAO.org*. FAO, 2012. Web. 1 Oct. 2013.

Polycarpou, Lakis. "The Year of Drought and Flood – State of the Planet." *State of the Planet The Year of Drought and Flood Comments*. N.p., 20 July 2011. Web. 1 Oct. 2013.

"Quantitative Assessment of Vulnerability to Climate Change." *ICRISAT.org*. Icrisat, 23 Oct. 2009. Web. 1 Oct. 2013.

"State Key Laboratories." *The Chinese University of Hong Kong*. The Chinese University of Hong Kong, 2013. Web. 1 Oct. 2013.

The Lord of the Rings the Fellowship of the Ring. New Line Home Entertainment, 2001. DVD.

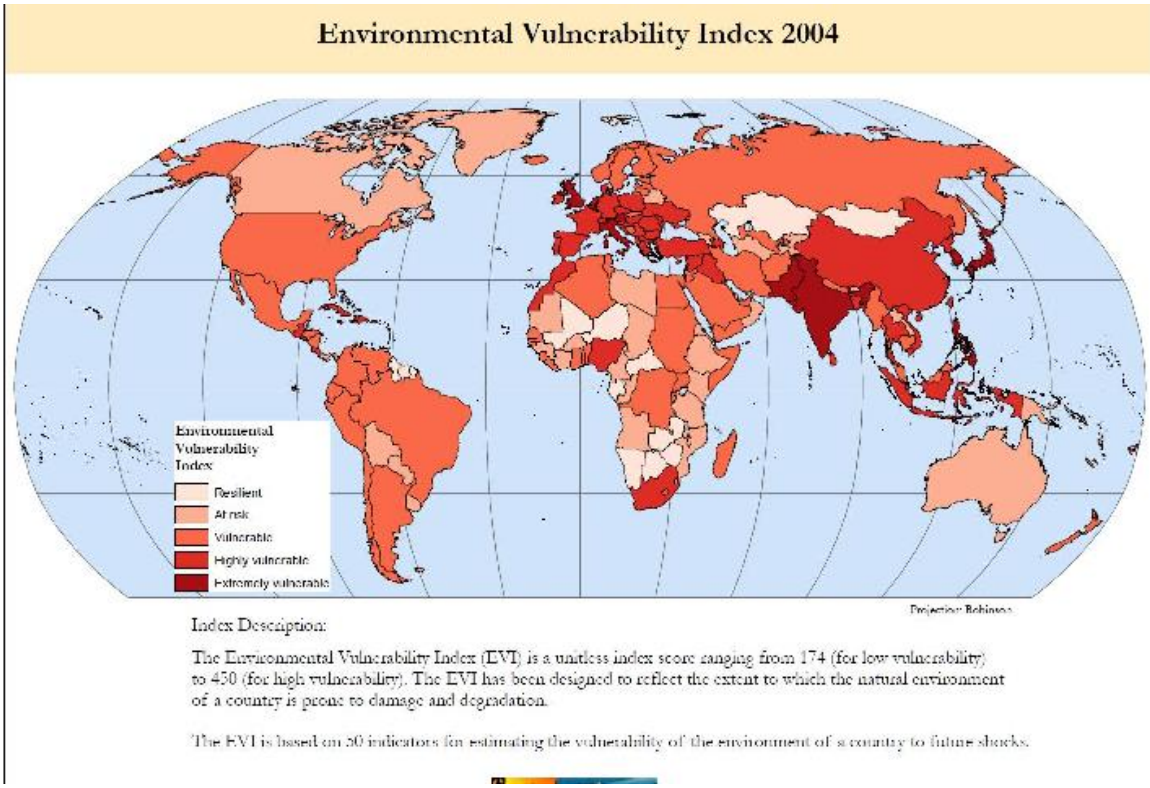
"Unemployed People in China by Province 2011." *Statista RSS*. Statista, Oct. 2012. Web. 1 Oct. 2013.

"Vulnerable." *Merriam-Webster*. Merriam-Webster, n.d. Web. 1 Oct. 2013.

Wang, Jinxia, Robert Mendelsohn, Ariel Dinar, Jikun Huang, Scott Rozelle, and Lijuan Zhang. "The Impact of Climate Change on China's Agriculture." *Ccap.org*. Agricultural Economics 40, 2009. Web. 1 Oct. 2013.

XIONG, Wei. "Impacts of Climate Change on Rice Production in China."*Agriskmanagementforum.org*. Chinese Academy of Agricultural Sciences, 16 Oct. 2012. Web. 1 Oct. 2013.

Appendix A



Source: http://sedac.ciesin.columbia.edu/

Appendix B

BJ- Beijing Municipality				
Month	1990-2009 Rainfall (mm)	1960-1990 Rainfall (mm)	1990-2009 Temperature (°C)	1960-1990 Temperature (°C)
January	3.78	3.08	-6	-4
February	3	4.9	-2.11	-1.5
March	5.62	7.96	4.56	5.6
April	20.36	21.46	11.89	13.8
May	29.1	30.47	18.58	20.1
June	66.22	64.51	22.74	24.4
July	141.82	164.23	25.16	26.6
August	87.25	142.82	23.71	25.5
September	31.93	43.94	18.65	20.5
October	33.67	19.17	10.93	13.7
November	10.95	5.88	2.34	5.1
December	4.43	2.9	-4.57	-1.9
Sum	**438.13**	**511.32**	**125.88**	**147.9**
Min	**3**	**2.9**	**-6**	**-4**
Max	**141.82**	**164.23**	**25.16**	**26.6**
Dif. In Min Temp				2
Dif. In Max Temp				-1.44
Dif. In Rainfall		-73.19		

TJ- Tianjin Municipality				
Month	1990-2009 Rainfall (mm)	1960-1990 Rainfall (mm)	1990-2009 Temperature (°C)	1960-1990 Temperature (°C)
January	3.9	3.15	-4	-3
February	3.16	4.86	-0.94	-0.87
March	5.49	6.86	5.71	6
April	21.81	23.4	12.94	13.97
May	29.16	32.58	19.56	20.41
June	65.25	65.76	23.46	24.73
July	154.49	177.25	25.89	26.64
August	89.49	148.32	24.77	25.92
September	32.45	45.32	20.02	21.17
October	34.98	20.77	12.6	14.38
November	16.5	9.95	3.86	5.9
December	5.79	3.86	-3.07	-1.16
Sum	**462.47**	**542.08**	**140.8**	**154.09**
Min	**3.16**	**3.15**	**-4**	**-3**
Max	**154.49**	**177.25**	**25.89**	**26.64**

Dif. In Min Temp		1
Dif. In Max Temp		-0.75
Dif. In Rainfall	-79.61	

HE- Hebei Province				
Month	**1990-2009 Rainfall (mm)**	**1960-1990 Rainfall (mm)**	**1990-2009 Temperature (°C)**	**1960-1990 Temperature (°C)**
January	3.16	2.04	-12	-4
February	3.25	5.85	-8.5	-1.39
March	8.41	10.97	-1.31	5.32
April	16.85	19.48	6.64	13.63
May	32.54	32.75	13.88	19.89
June	64.16	63.94	18.02	24.33
July	116.91	130.74	20.64	26.29
August	74.08	121.29	19.04	25.03
September	32.16	43.5	13.38	20.13
October	37	23.03	5.46	13.17
November	13.68	9.76	-3.77	4.91
December	3.88	2.92	-11.07	-1.97
Sum	**406.08**	**466.27**	**60.41**	**145.34**
Min	**3.16**	**2.04**	**-12**	**-4**
Max	**116.91**	**130.74**	**20.64**	**26.29**
Dif. In Min Temp				8
Dif. In Max Temp				-5.65
Dif. In Rainfall		-60.19		

SX- Shanxi Province				
Month	**1990-2009 Rainfall (mm)**	**1960-1990 Rainfall (mm)**	**1990-2009 Temperature (°C)**	**1960-1990 Temperature (°C)**
January	3.76	2.94	-10	-9
February	2.88	6.78	-5.38	-6.6
March	13.11	14.74	0.63	0.24
April	16.83	25.47	7.28	7.85
May	36.41	36.79	14.37	14.49
June	57.86	60.93	18.49	18.44
July	103.23	137.5	20.69	20.44
August	83.98	120.62	19.12	18.95
September	29.97	63.44	13.68	13.68
October	36.17	33.71	6.42	7.5
November	12.84	17.34	-1.82	-0.79
December	4.56	3.89	-9.04	-7.92
Sum	**401.6**	**524.15**	**74.44**	**77.28**
Min	**2.88**	**2.94**	**-10**	**-9**

Max	**103.23**	**137.5**	**20.69**	**20.44**
Dif. In Min Temp				1
Dif. In Max Temp				0.25
Dif. In Rainfall		-122.55		

NM- Inner Mongolia Autonomous District				
Month	**1990-2009 Rainfall (mm)**	**1960-1990 Rainfall (mm)**	**1990-2009 Temperature (°C)**	**1960-1990 Temperature (°C)**
January	1.23	2.1	-13	-18
February	1.05	3.03	-8.55	-12.98
March	4.24	4.3	-1.37	-3.51
April	6.29	8.93	7	6.31
May	21.99	16.24	14.83	14.28
June	39.52	33.53	20.32	19.75
July	64.21	70.07	23.13	22.61
August	45	70.65	21.2	20.5
September	12.18	29.69	14.65	13.73
October	10.02	12.73	5.26	5.58
November	2.1	2.98	-4.69	-5.16
December	1.17	1	-12.63	-14.03
Sum	**209**	**255.25**	**66.15**	**49.08**
Min	**1.05**	**1**	**-13**	**-18**
Max	**64.21**	**70.65**	**23.13**	**22.61**
Dif. In Min Temp				-5
Dif. In Max Temp				0.52
Dif. In Rainfall		-46.5		

LN- Liaoning Province				
Month	**1990-2009 Rainfall (mm)**	**1960-1990 Rainfall (mm)**	**1990-2009 Temperature (°C)**	**1960-1990 Temperature (°C)**
January	5.6	4.96	-9	-8
February	3.38	5.87	-4.72	-6.82
March	9.04	10.88	2.2	1.04
April	38.45	35.48	11.06	9.63
May	38.42	50.13	18.18	16.81
June	75.54	80.06	22.47	21.5
July	192.52	186.93	25.26	24.67
August	134.26	160.39	23.92	23.89
September	40.55	67.45	18.77	18.05
October	29.45	37.06	10.54	10.43
November	18.22	16.97	0.72	1.26
December	7.95	6.84	-7.18	-6.73
Sum	**593.38**	**663.02**	**112.22**	**105.73**

Min	**3.38**	**4.96**	**-9**	**-8**
Max	**192.52**	**186.93**	**25.26**	**24.67**
Dif. In Min Temp				1
Dif. In Max Temp				0.59
Dif. In Rainfall		-69.64		

JL- Jilin Province				
Month	**1990-2009 Rainfall (mm)**	**1960-1990 Rainfall (mm)**	**1990-2009 Temperature (°C)**	**1960-1990 Temperature (°C)**
January	4.5	3	-18	-19
February	3.13	4.05	-13.19	-15.37
March	10.9	11.59	-3.65	-5.91
April	32.89	32.65	6.23	4.61
May	66.81	61.95	12.99	11.82
June	95.48	103	18.47	16.79
July	218.24	168.33	21.71	20.16
August	108.26	144.74	20.19	19.23
September	49.61	60.38	13.5	12.43
October	36.33	31.77	5.21	4.22
November	10.85	13.01	-5.43	-5.99
December	5.73	3.01	-14.85	-15.07
Sum	**642.73**	**637.48**	**43.18**	**27.92**
Min	**3.13**	**3**	**-18**	**-19**
Max	**218.24**	**168.33**	**21.71**	**20.16**
Dif. In Min Temp				-1
Dif. In Max Temp				1.55
Dif. In Rainfall		5.25		

HL- Heilongjiang Province				
Month	**1990-2009 Rainfall (mm)**	**1960-1990 Rainfall (mm)**	**1990-2009 Temperature (°C)**	**1960-1990 Temperature (°C)**
January	4.48	3	-21	-24
February	3.9	3.03	-18.46	-21.26
March	8.39	9.25	-8.77	-10.91
April	32.77	28.56	3.66	1.59
May	55.55	51.71	11.64	9.5
June	70.45	94.36	17.06	15.59
July	145.92	143.67	20.32	18.8
August	103.01	136.99	18.38	16.84
September	54.28	72.96	11.48	10.1
October	31.51	25.63	2.29	0.69

November	6.9	12.69	-11.22	-12.67
December	6.17	6.87	-22	-22.82
Sum	**523.33**	**588.72**	**3.38**	**-18.55**
Min	**3.9**	**3**	**-22**	**-24**
Max	**145.92**	**143.67**	**20.32**	**18.8**
Dif. In Min Temp				-2
Dif. In Max Temp				-39.12
Dif. In Rainfall		-65.63		

SH- Shanghai Municipality				
Month	1990-2009 Rainfall (mm)	1960-1990 Rainfall (mm)	1990-2009 Temperature (°C)	1960-1990 Temperature (°C)
January	45.62	32.13	3.5	4
February	38.69	44.85	4.49	4.57
March	57.52	62.33	8.39	8.2
April	69	90.74	13.83	13.47
May	81.36	104.88	19.06	18.57
June	146.67	151.6	23.12	22.99
July	208.73	182.28	26.98	27.45
August	236.49	145.37	26.52	27.52
September	58.04	128.18	23.13	23.52
October	53.49	59.89	17.6	18.29
November	48.54	50.44	11.22	12.53
December	38.02	27.79	4.71	6.12
Sum	**1082.17**	**1080.48**	**182.55**	**187.23**
Min	**38.02**	**27.79**	**3.5**	**4**
Max	**236.49**	**182.28**	**26.98**	**27.52**
Dif. In Min Temp				-0.5
Dif. In Max Temp				-0.54
Dif. In Rainfall		1.69		

JS- Jiangsu Province				
Month	1990-2009 Rainfall (mm)	1960-1990 Rainfall (mm)	1990-2009 Temperature (°C)	1960-1990 Temperature (°C)
January	22.51	16.76	2	1
February	20.79	22.26	3.88	2.45
March	27.82	33.93	8.29	7.33
April	41.9	54.1	13.96	13.76
May	58.35	63.17	19.56	19.24
June	92.46	109.04	23.8	23.71
July	225.65	230.45	27.15	27.03
August	203.97	161.83	26.51	26.94
September	52.76	98.76	22.36	21.91

October	36.41	44.05	16.42	16.3
November	37.69	33.64	9.45	9.56
December	15.24	11.81	3.05	3.12
Sum	**835.55**	**879.8**	**176.43**	**172.35**
Min	**15.24**	**11.81**	**2**	**1**
Max	**225.65**	**230.45**	**27.15**	**27.03**
Dif. In Min Temp				1
Dif. In Max Temp				0.12
Dif. In Rainfall		-44.25		

ZJ- Zhejiang Province				
Month	**1990-2009 Rainfall (mm)**	**1960-1990 Rainfall (mm)**	**1990-2009 Temperature (°C)**	**1960-1990 Temperature (°C)**
January	75.06	49.72	5	4
February	69.32	75.13	6.67	4.97
March	94.32	106.24	10.55	8.67
April	111.45	130.13	15.93	14.3
May	150.2	158.14	20.38	19.03
June	249.06	195.65	24.14	22.84
July	141.03	140.47	28.26	27.25
August	264.58	147.83	27.19	26.87
September	73.42	160.44	24.03	22.92
October	75.47	83.53	18.43	17.84
November	55.2	60.49	12.79	12.4
December	81.55	43.98	6.89	6.59
Sum	**1440.66**	**1351.75**	**200.26**	**187.68**
Min	**55.2**	**43.98**	**5**	**4**
Max	**264.58**	**195.65**	**28.26**	**27.25**
Dif. In Min Temp				1
Dif. In Max Temp				1.01
Dif. In Rainfall		88.91		

AH- Anhui Province				
Month	**1990-2009 Rainfall (mm)**	**1960-1990 Rainfall (mm)**	**1990-2009 Temperature (°C)**	**1960-1990 Temperature (°C)**
January	29.52	18.76	2.5	2
February	31.53	29.21	5.41	3.44
March	51.9	45.44	10.61	8.81
April	47.57	67.31	15.74	15.54
May	93.23	77.4	21.49	21.02
June	123.21	110.62	25.88	25.59
July	191.51	203.51	28.32	27.78

August	168.07	135.49	27.24	27.28
September	43.11	91.55	23.02	22.19
October	45.32	55.15	17.38	16.71
November	33.24	32.97	10.43	10.01
December	30.32	13.8	4.31	3.71
Sum	**888.53**	**881.21**	**192.33**	**184.08**
Min	**29.52**	**13.8**	**2.5**	**2**
Max	**191.51**	**203.51**	**28.32**	**27.78**
Dif. In Min Temp				0.5
Dif. In Max Temp				0.54
Dif. In Rainfall		7.32		

FJ- Fujian Province				
Month	1990-2009 Rainfall (mm)	1960-1990 Rainfall (mm)	1990-2009 Temperature (°C)	1960-1990 Temperature (°C)
January	89.91	59.2	9	8
February	84.79	91.09	10.15	9.32
March	152.89	168.54	13.75	13.02
April	214.61	207.24	18	17.43
May	241.24	260.55	21.56	21.15
June	361.89	288.61	24.36	23.81
July	129.39	129.63	27.05	26.82
August	217.53	143.78	26.11	26.25
September	90.45	114.92	24.2	23.73
October	55.73	67.11	19.48	19.2
November	46.81	48.32	14.32	14.13
December	83.18	43.31	9.56	9.33
Sum	**1768.42**	**1622.3**	**217.54**	**212.19**
Min	**46.81**	**43.31**	**9**	**8**
Max	**361.89**	**288.61**	**27.05**	**26.82**
Dif. In Min Temp				1
Dif. In Max Temp				0.23
Dif. In Rainfall		146.12		

JX- Jiangxi Province				
Month	1990-2009 Rainfall (mm)	1960-1990 Rainfall (mm)	1990-2009 Temperature (°C)	1960-1990 Temperature (°C)
January	80.12	52.27	6	5
February	104.16	84.07	7.27	5.53
March	151.94	140.01	11.43	9.97
April	163.33	185.91	16.41	16.01

May	193.15	202.72	21.46	20.76
June	281.38	227.7	24.96	24.37
July	130.01	131.15	27.98	27.85
August	154.71	113.43	26.83	27.48
September	62.99	80.88	23.68	22.99
October	67.22	78.87	17.83	17.51
November	65.61	67.61	12.31	11.71
December	71.54	42.91	6.49	6.23
Sum	**1526.16**	**1407.53**	**202.65**	**195.41**
Min	**62.99**	**42.91**	**6**	**5**
Max	**281.38**	**227.7**	**27.98**	**27.85**
Dif. In Min Temp				1
Dif. In Max Temp				0.13
Dif. In Rainfall		118.63		

SD- Shandong Province				
Month	**1990-2009 Rainfall (mm)**	**1960-1990 Rainfall (mm)**	**1990-2009 Temperature (°C)**	**1960-1990 Temperature (°C)**
January	7.56	5.87	-1	-1.5
February	7.95	9.67	2.32	0.77
March	9.22	15.95	8.41	7.15
April	28.98	37.3	15.08	14.58
May	33.7	38.92	21.39	20.85
June	67.42	83.63	25.71	25.36
July	183.1	215.24	27.46	26.56
August	130.56	152.22	25.96	25.61
September	40.37	68.59	21.65	20.94
October	44.84	34.55	15.07	15.08
November	25.73	16.9	7.21	7.34
December	7.94	6.83	0.47	0.44
Sum	**587.37**	**685.67**	**169.73**	**163.18**
Min	**7.56**	**5.87**	**-1**	**-1.5**
Max	**183.1**	**215.24**	**27.46**	**26.56**
Dif. In Min Temp				-0.5
Dif. In Max Temp				0.9
Dif. In Rainfall		-98.31		

HA- Henan Province				
Month	**1990-2009 Rainfall (mm)**	**1960-1990 Rainfall (mm)**	**1990-2009 Temperature (°C)**	**1960-1990 Temperature (°C)**
January	16.94	9.05	1.5	1
February	15.4	14.53	4.73	2.96

March	30.94	28.71	10.16	8.43
April	39.85	52.66	14.81	14.95
May	70.36	57.9	21.11	20.58
June	85.68	71	25.95	25.76
July	114.54	160.82	27.52	27.09
August	123.28	121.24	26.14	26.21
September	48.96	88.55	21.56	21.05
October	42.8	52.33	16.01	15.67
November	23.46	27.54	8.86	8.85
December	19.79	8.81	2.6	2.85
Sum	**632**	**693.14**	**180.95**	**175.4**
Min	**15.4**	**8.81**	**1.5**	**1**
Max	**123.28**	**160.82**	**27.52**	**27.09**
Dif. In Min Temp				0.5
Dif. In Max Temp				0.43
Dif. In Rainfall		-61.14		

HB- Hubei Province				
Month	**1990-2009 Rainfall (mm)**	**1960-1990 Rainfall (mm)**	**1990-2009 Temperature (°C)**	**1960-1990 Temperature (°C)**
January	28.49	20.84	3	3.5
February	32.58	31.88	6.72	4.76
March	51.67	55.25	11.61	9.84
April	62.58	92.2	15.94	16.11
May	111.48	111.29	21.84	21.49
June	127.89	130.8	26.17	26.05
July	149.54	162.54	28.3	28.17
August	132.32	128.54	27.3	27.51
September	60.36	104.31	23.08	22.4
October	56.23	73.69	17.7	17.19
November	33.71	45.8	11.2	10.92
December	26.97	15.66	5.04	4.89
Sum	**873.82**	**972.8**	**197.9**	**192.83**
Min	**26.97**	**15.66**	**3**	**3.5**
Max	**149.54**	**162.54**	**28.3**	**28.17**
Dif. In Min Temp				-0.5
Dif. In Max Temp				0.13
Dif. In Rainfall		-98.98		

HN- Hunan Province				
Month	**1990-2009 Rainfall (mm)**	**1960-1990 Rainfall (mm)**	**1990-2009 Temperature (°C)**	**1960-1990 Temperature (°C)**

January	53.23	46.16	7	6
February	75.15	66.41	8.19	6.51
March	109	118.1	12.27	11.09
April	131.09	163.72	17.22	17.18
May	178.61	178.24	22.35	22.19
June	216.59	194.95	26.25	25.9
July	144.76	131.71	29.13	29.52
August	133.35	119.06	28.04	28.95
September	63.66	79.4	24.38	24.13
October	70.75	84.02	18.83	18.82
November	68.26	69.21	13.01	13.03
December	49.8	40.04	7.18	7.45
Sum	**1294.25**	**1291.02**	**213.85**	**210.77**
Min	**49.8**	**40.04**	**7**	**6**
Max	**216.59**	**194.95**	**29.13**	**29.52**
Dif. In Min Temp				1
Dif. In Max Temp				-0.39
Dif. In Rainfall		3.23		

GD- Guangdong Province				
Month	1990-2009 Rainfall (mm)	1960-1990 Rainfall (mm)	1990-2009 Temperature (°C)	1960-1990 Temperature (°C)
January	56.11	53.32	13	14.2
February	79.12	65.91	14.61	14.58
March	99.18	92.7	17.98	18
April	215.53	189.06	22.03	22.06
May	261.39	288.2	25.66	25.98
June	324.4	264.19	27.71	27.72
July	258.76	220.78	28.43	28.91
August	303.04	237.19	28.32	28.67
September	198.8	166.8	26.77	27.41
October	70.53	79.33	23.8	24.18
November	33.19	42.95	19.01	19.66
December	58.05	24.87	14.98	15.39
Sum	**1958.1**	**1725.3**	**262.3**	**266.76**
Min	**33.19**	**24.87**	**13**	**14.2**
Max	**324.4**	**288.2**	**28.43**	**28.91**
Dif. In Min Temp				-1.2
Dif. In Max Temp				-0.48
Dif. In Rainfall		282.8		

GX- Guangxi Zhuang Autonomous Region

Month	1990-2009 Rainfall (mm)	1960-1990 Rainfall (mm)	1990-2009 Temperature (°C)	1960-1990 Temperature (°C)
January	37.75	35.68	13.55	13
February	45.63	49.48	14.46	13.21
March	76.98	62.74	17.79	16.89
April	114.09	132.44	22.27	21.5
May	205.64	208.14	25.44	25.45
June	261.67	222.84	27.47	27.25
July	304.2	203.08	28.23	28.36
August	264.68	213.39	28.05	28.05
September	91.99	109.83	26.63	26.6
October	72.41	77.64	23.23	23.05
November	44.96	50.93	18.82	18.19
December	42.62	26.64	14.39	14.03
Sum	**1562.62**	**1392.83**	**260.33**	**255.58**
Min	**37.75**	**26.64**	**13.55**	**13**
Max	**304.2**	**222.84**	**28.23**	**28.36**
Dif. In Min Temp				0.55
Dif. In Max Temp				-0.13
Dif. In Rainfall		169.79		

HI- Hainan Province

Month	1990-2009 Rainfall (mm)	1960-1990 Rainfall (mm)	1990-2009 Temperature (°C)	1960-1990 Temperature (°C)
January	19.23	26.34	19	17.5
February	31.08	26.31	19.85	19.23
March	46	40.64	23.06	22.07
April	53.51	97.76	26.45	25.09
May	193.48	199	27.65	27.01
June	266.31	215.4	28.9	27.47
July	342.56	233.17	28.33	27.6
August	410.31	278.26	28.03	26.86
September	362.08	352.62	26.86	25.97
October	212.75	253.98	25.26	24.11
November	75.15	129.08	22.17	21.34
December	77.24	47.98	19.48	18.64
Sum	**2089.7**	**1900.54**	**295.04**	**282.89**
Min	**19.23**	**26.31**	**19**	**17.5**
Max	**410.31**	**352.62**	**28.9**	**27.6**
Dif. In Min Temp				1.5
Dif. In Max Temp				1.3
Dif. In Rainfall		189.16		

CQ- Chongqing Municipality				
Month	1990-2009 Rainfall (mm)	1960-1990 Rainfall (mm)	1990-2009 Temperature (°C)	1960-1990 Temperature (°C)
January	18.52	16.62	5	4
February	22.28	21.79	6.65	4.94
March	46.02	53.84	10.93	9.41
April	91.43	109.75	14.86	14.49
May	144.52	160.65	18.97	18.62
June	179.26	176.78	22.29	21.48
July	163.36	175.54	25.28	24.57
August	129.16	137.19	25.21	24.69
September	118.55	158.05	20.99	20.3
October	110.09	111.46	15.62	15.27
November	48.99	56.42	10.77	10.07
December	27.83	23.69	7.32	5.52
Sum	**1100.01**	**1201.78**	**183.89**	**173.36**
Min	**18.52**	**16.62**	**5**	**4**
Max	**179.26**	**176.78**	**25.28**	**24.69**
Dif. In Min Temp				1
Dif. In Max Temp				0.59
Dif. In Rainfall		-101.77		

SC- Sichuan Province				
Month	1990-2009 Rainfall (mm)	1960-1990 Rainfall (mm)	1990-2009 Temperature (°C)	1960-1990 Temperature (°C)
January	3.2	2.04	-2	-3
February	5.57	7.35	0.74	-1
March	15.36	20.99	4.11	2.86
April	40.12	42.9	7.21	6.6
May	71.36	86.99	10.26	9.81
June	136.96	139.85	12.57	11.67
July	129.09	135.31	14.78	14
August	100.68	116.2	14.11	13.82
September	111.3	114.48	11.63	10.87
October	43.46	50.79	7.61	6.87
November	5.93	8.12	2.69	1.58
December	0.86	2.91	1.71	-2.27
Sum	**663.89**	**727.93**	**85.42**	**71.81**
Min	**0.86**	**2.04**	**-2**	**-3**
Max	**136.96**	**139.85**	**14.78**	**14**
Dif. In Min Temp				-1
Dif. In Max Temp				0.78
Dif. In Rainfall		-64.04		

GZ-Guizhou Province				
Month	**1990-2009 Rainfall (mm)**	**1960-1990 Rainfall (mm)**	**1990-2009 Temperature (°C)**	**1960-1990 Temperature (°C)**
January	22.47	21.84	5.8	5
February	21.48	21.5	7.17	5.77
March	40.66	37	11.32	10.65
April	112.63	107.52	15.64	15.81
May	162.89	174.72	19.51	19.77
June	228.35	201.02	22.59	22.43
July	217.74	154.56	25.21	24.87
August	142.09	137.07	24.33	24.31
September	78.58	101.09	21.22	21.06
October	101.54	99.04	16.26	16.32
November	46.47	55.2	11.74	11.15
December	26.59	24.62	8.45	6.56
Sum	**1201.49**	**1135.18**	**189.24**	**183.7**
Min	**21.48**	**21.5**	**5.8**	**5**
Max	**228.35**	**201.02**	**25.21**	**24.87**
Dif. In Min Temp				0.8
Dif. In Max Temp				0.34
Dif. In Rainfall		66.31		

YN- Yunnan Province				
Month	**1990-2009 Rainfall (mm)**	**1960-1990 Rainfall (mm)**	**1990-2009 Temperature (°C)**	**1960-1990 Temperature (°C)**
January	9.86	9.83	9.8	6.8
February	12.3	10.79	11.53	9.73
March	18.73	14.61	14.51	12.85
April	21.83	28.17	18.02	16.12
May	95.85	86.69	19.02	19.19
June	219.52	185.55	20.98	20.03
July	232.4	217.76	21.01	10.17
August	227.72	203.77	20.43	19.66
September	135.55	138.78	19.37	18.17
October	90.9	88.36	16.87	15.55
November	34.08	36.52	12.65	11.49
December	6.9	12.77	9.87	8.18
Sum	**1105.64**	**1033.6**	**194.06**	**167.94**
Min	**6.9**	**9.83**	**9.8**	**6.8**
Max	**232.4**	**217.76**	**21.01**	**20.03**
Dif. In Min Temp				3
Dif. In Max Temp				0.98

Dif. In Rainfall	72.04	

XZ- Tibet Autonomous Region				
Month	1990-2009 Rainfall (mm)	1960-1990 Rainfall (mm)	1990-2009 Temperature (°C)	1960-1990 Temperature (°C)
January	3.74	3.88	-15	-15
February	7.44	5.79	-13.13	-13.28
March	8.92	9.09	-10.18	-9.51
April	14.1	10.64	-5.31	-4.6
May	12.6	16.52	-0.41	-0.05
June	71.6	78.25	4.28	4.78
July	106.59	127.05	6.24	6.72
August	92.01	122.55	5.68	6.02
September	43.52	56.2	2.59	3.35
October	5.37	10.37	-4.23	-3.59
November	3.49	4.88	-10.88	-10.59
December	9.05	5.78	-15.07	-13.93
Sum	**378.43**	**451**	**-55.42**	**-49.68**
Min	**3.49**	**3.88**	**-15.07**	**-15**
Max	**106.59**	**127.05**	**6.24**	**6.72**
Dif. In Min Temp				0.07
Dif. In Max Temp				-0.48
Dif. In Rainfall		-72.57		

SN- Shaanxi Province				
Month	1990-2009 Rainfall (mm)	1960-1990 Rainfall (mm)	1990-2009 Temperature (°C)	1960-1990 Temperature (°C)
January	4.58	2.94	-1.7	-2
February	2.57	5.84	1.18	-0.38
March	15.85	19.17	6.6	5.9
April	27.3	37.31	11.93	12.46
May	41.02	48.56	17.32	17.74
June	58.69	55.56	21.68	22.13
July	93.87	120.02	23.96	23.96
August	93.06	98.18	22.51	22.92
September	86.17	93.33	17.18	17.47
October	38.22	45.67	11.29	11.77
November	12.74	19.9	4.34	4.55
December	6.2	3.9	-2.14	-1.91
Sum	**480.27**	**550.38**	**134.15**	**134.61**
Min	**2.57**	**2.94**	**-2.14**	**-2**
Max	**93.87**	**120.02**	**23.96**	**23.96**
Dif. In Min				0.14

Temp		
Dif. In Max Temp		0
Dif. In Rainfall	-70.11	

GS- Gansu Province				
Month	1990-2009 Rainfall (mm)	1960-1990 Rainfall (mm)	1990-2009 Temperature (°C)	1960-1990 Temperature (°C)
January	1.21	0.97	-6	-7
February	1.98	2.96	-2.42	-4.46
March	8.18	11.02	2.72	1.45
April	21.43	29.53	8.23	7.58
May	51.28	49.24	12.71	12.3
June	54.93	53.79	17	15.43
July	80.44	78.98	18.82	17.61
August	69.07	84.81	17.84	16.89
September	70.4	69.12	13	12.05
October	24.45	33.07	7.32	6.69
November	2.81	6.97	0.79	-0.07
December	0.61	0.98	-5.16	-5.59
Sum	**386.79**	**421.44**	**84.85**	**72.88**
Min	**0.61**	**0.97**	**-6**	**-7**
Max	**80.44**	**84.81**	**18.82**	**17.61**
Dif. In Min Temp				-1
Dif. In Max Temp				1.21
Dif. In Rainfall		-34.65		

QH- Qinghai Province				
Month	1990-2009 Rainfall (mm)	1960-1990 Rainfall (mm)	1990-2009 Temperature (°C)	1960-1990 Temperature (°C)
January	1.78	0.97	-14.5	-17
February	0.91	1.02	-11.05	-14.49
March	5.25	4.87	-6.77	-9.7
April	5.22	3.93	-1.51	-4.56
May	18.74	19.62	3.09	0.29
June	42.97	49.9	7.26	3.77
July	51.04	45.37	9.74	6.64
August	29.79	39.56	8.8	6.08
September	35.89	33.72	4.96	2.31
October	10.48	10.94	-1.9	-4.07
November	1.45	1.95	-8.67	-12.02
December	0.82	0.95	-13.06	-15.76
Sum	**204.34**	**212.8**	**-23.61**	**-58.51**
Min	**0.82**	**0.95**	**-14.5**	**-17**

Max	**51.04**	**49.9**	**9.74**	**6.64**
Dif. In Min Temp				-2.5
Dif. In Max Temp				3.1
Dif. In Rainfall		-8.46		

NX- Ningxia Hui Autonomous Region				
Month	**1990-2009 Rainfall (mm)**	**1960-1990 Rainfall (mm)**	**1990-2009 Temperature (°C)**	**1960-1990 Temperature (°C)**
January	0.78	0.96	-6	-8.3
February	1.75	2.89	-1.72	-4.91
March	5.84	6.22	4.57	1.93
April	15.85	17.53	11.03	8.97
May	29.38	24.11	16.79	14.34
June	21.26	28.55	21.6	18.23
July	44.45	60.33	23.59	20.52
August	56.74	69.27	21.71	19.15
September	58.01	48.03	16.17	13.97
October	14.99	21.1	9.54	7.98
November	3.35	7.79	1.9	0.38
December	0.01	0.01	-5.33	-5.9
Sum	**252.41**	**286.79**	**113.85**	**86.36**
Min	**0.01**	**0.01**	**-6**	**-8.3**
Max	**58.01**	**69.27**	**23.59**	**20.52**
Dif. In Min Temp				-2.3
Dif. In Max Temp				3.07
Dif. In Rainfall		-34.38		

XJ- Xinjiang Uyghur Autonomous Region				
Month	**1990-2009 Rainfall (mm)**	**1960-1990 Rainfall (mm)**	**1990-2009 Temperature (°C)**	**1960-1990 Temperature (°C)**
January	2.87	2.03	-7.5	-3.6
February	1.61	0.98	0.37	-0.93
March	4.15	3.99	8.42	8.19
April	10.89	5.94	15.19	16.29
May	4.56	7.03	21.82	22.23
June	12.53	10.92	25.46	25.68
July	18.53	14.21	26.35	27.24
August	9.76	8.8	25.93	26.47
September	3.8	7.85	20.15	20.95
October	4.19	5.88	12.36	12.85
November	2.94	3.93	4.43	3.32
December	5.05	0.99	-5.82	-4.92

Sum	**80.88**	**72.55**	**147.16**	**153.77**
Min	**1.61**	**0.98**	**-7.5**	**-4.92**
Max	**18.53**	**14.21**	**26.35**	**27.24**
Dif. In Min Temp				2.58
Dif. In Max Temp				-0.89
Dif. In Rainfall		8.33		