THE IDENTIFICATION AND ANALYSIS OF HUMAN CAUSATION IN ATROCIOUS AND ABNORMAL NATURAL DISASTERS BY THE METHOD OF SATELLITE REMOTE SENSING

Na Yang *, Liangming Liu

School of Remote Sensing and Information Engineering, Wuhan University, Wuhan Hubei China, 430079, - yangna3565@yahoo.com.cn or lm_liu69@sohu.com

Commission VIII, WG VIII/3

KEY WORDS: Disaster, Sustainable, Climate, Inspection, Modelling, Analysis

ABSTRACT:

On the basis of climate change and natural disasters in China during the past ten years, and with the help of satellite remote sensing data (MODIS), we make experiments on the Heat Island Effect of Beijing, vegetation coverage in the Greater and Xiaoxing'anling Mountains, and heat distribution in the Yangtze River Basin. By making use of an integrative collection of variety information including population distribution, land coverage and utilization, super-scaled projects and so forth, we calculate Land Surface Temperature (LST) and Normalized Difference Vegetation Index (NDVI) in order to find clues to prove that human beings have the responsibility for causing atrocious and abnormal natural disasters.

1. INTRODUCTION

The Earth is compelled to suffer a challenge of vital importance without any willingness. With characteristics of arbitrariness in landform changing, immoderation in natural resources exploitation and irrationality in large-scaled projects construction, it seems those influences that we have imposed on the Earth are negative and devastating in the past hundred years, which we call times of Industrial or Science-Technology Revolution.

The complexity of forecasting and predicting natural disasters doesn't become easy along with our increased knowledge; on the contrary, with their newly evolved characteristics such as great unpredictability, irregularity and diversity, researches that focus on their performances seem only treating the symptoms but not the root causes. In fact, human beings have so special position in biological chain and the Earth's Layers, that our status have gradually changed from victims to accomplices or even murderers, when factors of society, politics, economy and culture have more and more subjective authorities in the environment decision making.

2. A FRAGILE TREND OF THE CITY ECOLOGICAL ENVIRONMENT

Big cities (regions) with a great density of population coincide with centres of high temperature on images of satellite remote sensing. These dense regions with low coverage of vegetation have extremely high release of carbon dioxide and exhaust heat; their function of heat accumulation is so great that could make direct influence on the regional energy cycle and trigger phenomena like drought, rainstorm and sandstorm. On the other hand, processes of energy transformation and diversion have been changed from complex to simple as a result of the simplification of biodiversity, the city ecological environment is being driven to a frangible direction and having its capability of resisting natural disasters lost.

Take Beijing for example, the statistical data says that its resident population is 16.33 million in 2007; the density in the centre of capital is 22394 person-per-km^2. With MODIS data, we make studies on the Heat Island Effect (Gao Mao-fang et al., 2007; Yan Feng et al., 2007; Nitin K. Singh & Sreekala G. Bajwa, 2007) of Beijing during the period of 2003~2007, and figure 1 is the land surface temperature (290~320K, MODIS, 1km) of this area in 2003-09-10 (U_L), 2005-09-14 (U_R) and 2007-09-04 (Below) respectively, we can see clearly that the temperature has a feature of annular distribution and the central region with high temperature is growing annually.
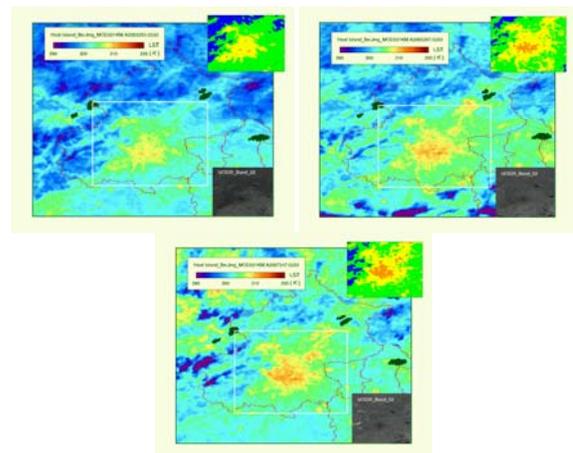

Figure 1. Heat Island Effect of Being in 2003, 2005 and 2007

We draw a white frame around the city main body, and give its temperature grades as the little picture in upper-right, the little grey one in lower-right is the reflectance of MODIS band 2 for the whole region.
We make four temperature grades of the city main body with different population density, as shown in table 1: the capital-

core-area (Orange) grows fastest with top population density; the function-expanded-region (Yellow) comes to heel, and the new-developed-area (Green) seems having not much change, while the ecological-conservation-zone (Blue) which should have high vegetation coverage undergoes a sharp decrease.

Population Density	Temperature	2003	2005	2007
22394	> 309	0.3	4.02	6.2
6312	305 ~ 309	18.67	40.4	33.45
709	301 ~ 305	62.14	50.12	53.94
200	< 301	18.66	5.36	6.3
person-per-km^2	K	%	%	%

Table 1. Temperature grades and their ratio in area

For verifying the changing-relationships among land types, land surface temperature and vegetation coverage, we choose points of 2003 and 2007 in a line of 39.92N, 115.19~117.69E. Solid lines of red, green and dark-blue in figure 2 represent LST (290~320K, MODIS, 1km), NDVI (0~0.8, MODIS, 1km) and reflectance (0~0.8, MODIS, 1km) distributions of 2003, and lines of pink, light-green and sky-blue with diamonds are for values of 2007 (the sharp downside in 115.7E is caused by cloud).
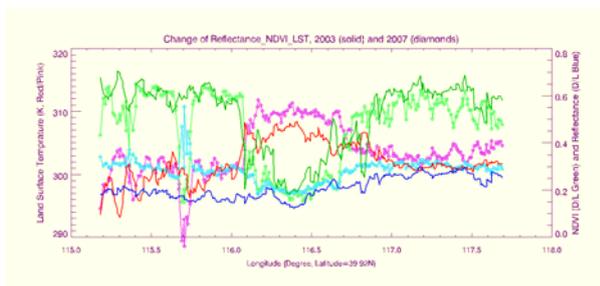

Figure 2. Reflectance, NDVI and LST in the line of 39.92N, 115.19~117.69E, 2003 and 2007

We can see dramatically opposed characteristics of land coverage and development trend in city-centre and suburban regions: the former has higher temperature and lower vegetation coverage, and the latter is exactly reversed. The overall trend of NDVI is decreasing from 2003 to 2007, but the temperature has an opposite trend in this period, and a wide range appears in its middle part (city centre). The reflectance of suburban areas also shows a remarkable increase and this reflects the city's expansion and its coverage transformation to some extent.

The sharp decrease of the ecological-conservation-zone and fast explosion of the capital-core-area from 2003 to 2007 makes great contrast: alterations of land coverage and regional hydrothermal conditions within a short period of time will put heavy load to the self-adaptive cycle of energy and water, therefore, coming along those extreme or abnormal weathers, and some times frequently.

3. INSPECTION OF DEGENERATE PROCESSES

Satellite remote sensing has the predominance of long-time monitoring and change detection. With years-maps of land classification, we could get an overall trend on courses of degradation like desertification, soil-and-water loss. The quantificational information of woodland, farmland and residential-land which obtained from satellite remote sensing data reflects the transformation of the atmospheric underlying surface (He Xuezhao et al., 2002). The land type alteration would change or even interrupt the local energy and water cycle in quite a short period and therefore, has un-shirkable responsibilities in happenings of disasters like drought, flood, rock-mud flow etc.

The forests in the Greater and Xiaoxing'anling Mountains have key role in climate regulation of North-East China. We calculate the mean NDVI (2000~2007, MODIS, 1km) of this region from June to September which shown in figure 3.
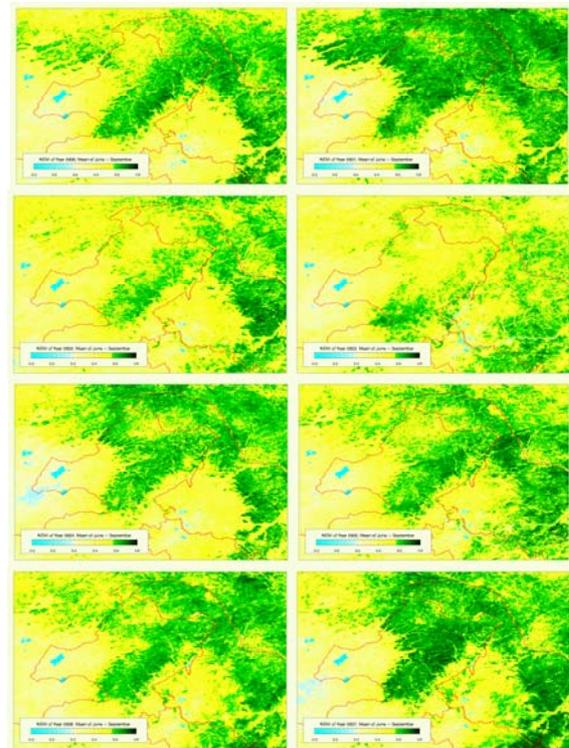

Figure 3. Mean NDVI of Heilongjiang and north-east Inner Mongolia, June~September, 2000~2007, -0.2~0.8

There is an obvious increase in the picture of 2001, and then follows a sharp and successive decrease in 2002 and 2003, the truth is that continuous drought of large-scale happens in the spring and some places of this region even get their first rain till mid-July that year. Take 2004 as the beginning, the NDVI values get a rebound and exceed 2000's level gradually.

We choose values located in lines of 51.9846N, 48.1857N, 44.9525N respectively, and analyze their distribution in years of 2001~2007, with the 2000's a standard.

The y-axis in figure 4 represents the ratio that other years' NDVI values greater than those of 2000's and the x-axis is for different years. There are cities located in the line of low-

latitude (44.9525N, Green), and its NDVI values are always higher than that of the 2000's, but having an overall decreasing trend, this just accords with the fact of city expansion and its land type-changing. The mid-latitude line (48.1857N, Blue) which goes across the Greater xing'an Mountains and central areas of Heilongjiang province has a continuous decrease in 2003 and 2004, but the whole level is above the 2000's and we can see a slightly upward trend. The high-latitude line (51.9846N, Red) passes through forests of Xiaoxing'anling Mountains, there is a big fluctuation from 2000~2004, and the overall trend wanders about the line of 50% with no explicit increase.
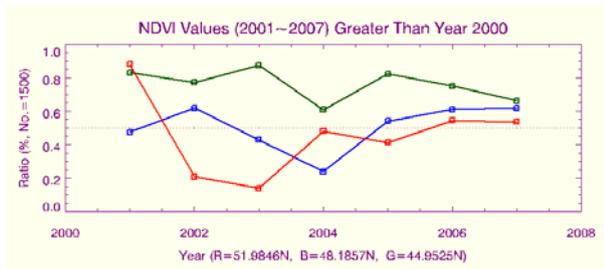

Figure 4. Ratios of 2001~2007 compared with 2000's in latitude of 51.9846N_R, 48.1857N_B and 44.9525N_G

Figure 5 makes us see the fluctuation clearly in the line of 51.9846N during 2001~2004, the y-axis is for 2000 and the x-axis is for the other years: most values concentrate on the side of 2001 at first, then completely reversed in pictures of 2002 and 2003, while in 2004, there comes a balance, just as shown in figure 3 and 4.
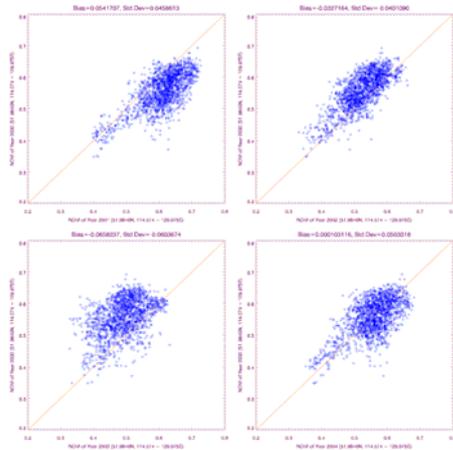

Figure 5. Comparing NDVI values in the line of 51.9846N, 2001~2004, -0.2~0.8

According to the vegetation coverage, we find no trace for processes of deforestation and desertification in the period of 2000~2007, there seems to be a stable development of the ecological environment in this region. However, from the end of last century, abnormal phenomenons like "dark-day in rainstorm" and "snow in May" appear in many places of Heilongjiang province and records for drought, high temperature and sandstorm rise annually. Heavy snows in the winter always come late in the early spring. In mid-April 2005, there is such a heavy blizzard in the Songnen Plain that to be

the maximum since 1951. There we could say that all this is only a little tip of the iceberg of the global warming.

4. CLIMATE CHANGE CAUSED BY SUPER-SCALED ARTIFICIAL CONSTRUCTIONS

These super-scaled artificial constructions have a far-reaching influence on the global climate. In fact, this holistic impact gets a distinct "Buffer" course from infliction to being noticed, and meanwhile, an inertial character emerges and the influence is irreversible in quite a long time when this happened.

Take the Three Gorges Dam for example, as a world-famous water conservancy projects, its impact on the global climate is also world-class. We suppose the gigantic intercept and climbing water-level will inevitably remodel the heat distribution of the Yangtze River Basin, the old pattern has been broken and the new one is growing gradually.

We calculate the LST (mean from October to December) and NDVI of the Yangtze River Basin from 2000 to 2007 with MODIS data (1km). In figure 6 there are LST (273~313K) and NDVI (-0.4~0.7) of 2000, 2003 and 2007 respectively, though we don't have enough satellite data to prove whether those heat centres enhanced or diverted just after the construction of this great dam in 1993, we see clearly that real changes have happened: banded zones of temperature that approximately paralleling the latitude have been replaced by enhanced heat centres. The heat accumulation in provinces of Hubei, Hunan and Jiangxi has an enlarging trend in both area and intensity. While as we pay attention to those NDVI pictures, there seems no violent change happened to this area's vegetation coverage, there we may have the conclusion that the heat remodelling is not simply caused by any processes of degradation or the result of urbanisation. The Yangtze River just likes a huge channel for heat and energy transformation, and close it down will definitely affect the global climate sooner or later: induce a new pattern, bring along extreme weather phenomena, or even form entirely different climate zones.
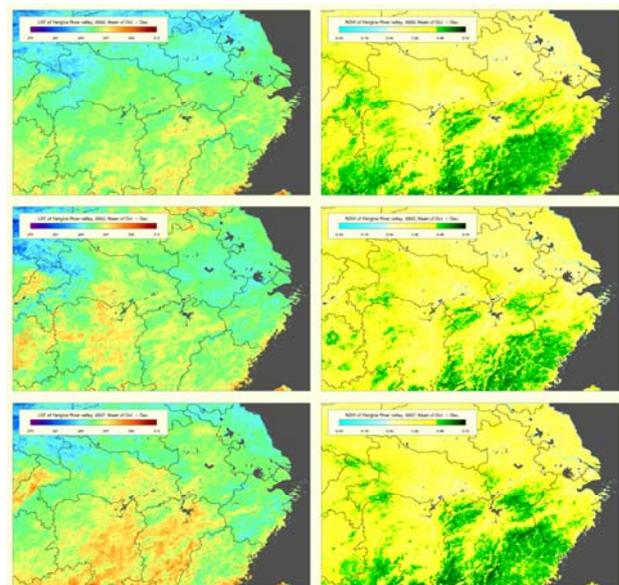

Figure 6. LST and NDVI of the Yangtze River Basin, 2000, 2003 and 2007

Frankly speaking, abnormal weather conditions have happened in this region, like strong typhoons with high frequency, successive high temperature of Chongqing in the summer of 2006, and later a warm winter for Wuhan, while in the winter of 2007, the whole Central China suffers an unprecedented snow-ice disaster.

We make 17 temperature grades (see appendix) and calculate their proportions in this area, figure 7 shows the results of 2001 (Blue), 2003 (Green), 2005 (Pink) and 2007 (Red), the overall trend is moving to higher temperature, and the difference among grades is diminishing, grades represent low temperature have their proportions decreasing, and increasing for those representing high temperature.
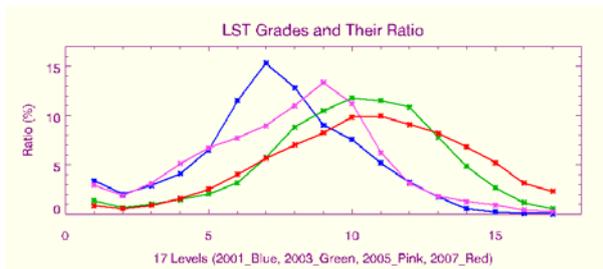

Figure 7. Areal proportions for 17 LST grades

Chongqing, Wuhan and Nanjing those traditional "stove" cities are all located along the Yangtze River, it is said that new "stove" cities like Hangzhou, Shanghai and Guangzhou are coming forth recently. On the basis of LST in this region, we choose Wuhan (113.9~114.9E, 30.1~31.1N), Nanchang (115.5~116.5E, 28.2~29.2N) Hangzhou (119.4~120.4E, 29.6~30.6N) and Shanghai (120.9~121.9E, 30.6~31.6N) to be samples.

Figure 8 shows the maximum (Red), mean (Green) and minimum (Blue) LST of these four cities from 2000 to 2007. The old "stove" city of Wuhan (Solid) has superiority in both mean and minimum levels, but always inferior in the maximum level. To our surprise, Nanchang (Dash Dot) holds the throne in the level of maximum temperature, and there is obvious fluctuation in the level of minimum, however, Hangzhou (Dotted) and Shanghai (Long Dashes) are similar in the three levels, there is no evident difference between them and they both have an overall trend with no big fluctuation.
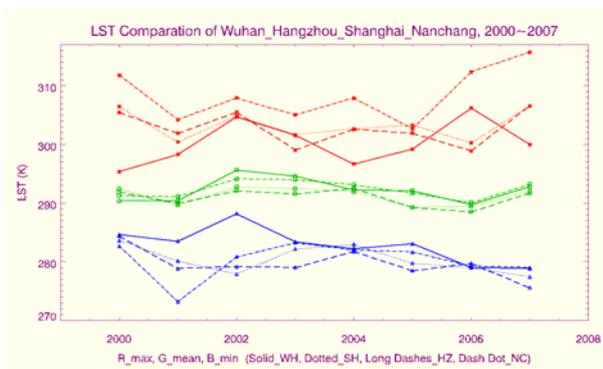

Figure 8. LST of maximum, mean and minimum for Wuhan (solid), Nanchang (dash dot), Hangzhou (dotted) and Shanghai (long dashes), 2000~2007

We also make figure 9 for seeing those cities' temperature distribution clearly and Wuhan to be the standard. The star, triangle and diamond represent Shanghai, Hangzhou and Nanchang respectively, and it seems truly that new "stove" cities have been born for most maximum values concentrate below the diagonal. But the case of higher temperature in the level of minimum for Wuhan, explains the influence of relative-warm water effect from the Yangtze River to some extent.
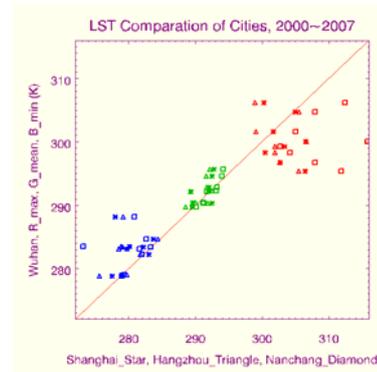

Figure 9. LST comparison among cities of Wuhan, Nanchang (Diamond), Shanghai (Star) and Hangzhou (Triangle)

While in fact, as it is too hard to find sunny data without any cloud in this region with such abundant water vapour, we could only make our experiment during the season of winter (Oct~Dec). Those results may not totally answer these climatic puzzles, but our hypotheses are partially validated.

5. CONCLUSIONS

Although we do not have enough proof, objectively speaking, most climate changes do come from our human's behaviour, except that caused by the Earth itself. It is wise to inspect ourselves while complaining the inconstant weather phenomena. And with the "Buffer" character, maybe we are repaying the debt for our ancestors who lived hundreds or thousands years ago, and maybe the most forceful culmination is still on its way, though we have already undergone the barbaric climate nowadays.

The objective recording of the Earth information by images of satellite remote sensing promotes our discovery on the induced factor of human beings in the abnormal global climate and high frequency of natural disasters, as to be one of the most active and unstable elements in the bio-sphere that laying in the bottom of these Earth Spheres, one small step for human beings could make giant leap of the nature. Efforts for making penetrate understandings of the relationship between human being and the nature are hope to have positive contributions in the exploration of harmonious developments of our society and the maintenance of the world's sustainable advancements. Limited to the disadvantage of traditional optical remote sensing, much precious behaviour of the climate and land cover features could not be detected, and as a study for climate change, only a ten-year time sequence is too short to make definite conclusions, but we hope the above results are qualified to be references in the research of global climate change.

REFERENCES

References from Journals:
Gao Mao-fang, Qin Zhi-hao, XU Bin. Estimation of the basic parameters for deriving surface temperature from MODIS data. Arid zone research, 2007 (1), pp. 113-119.

Yan Feng, Qin Zhihao, Li Maosong, Wang Yanjiao. On urban heat island of Shanghai city from MODIS data. Geomatics and information science of Wuhan University, 2007 (7), pp. 576-580.

Nitin K. Singh, Sreekala G. Bajwa. Analysis of evolving surface urban heat island in NW Arkansas. 2007 IEEE region 5 technical conference, April 20-21, Fayetteville, AR, pp. 409-414.

He Xuezhao, Shi Peijun, Gong Daoyi. Spatial features of the coupling between sprint NDVI and Temperature over northern hemisphere. Acta Geographica Sinica, 2002 (5), pp. 505-514.

APPENDIX

Grades	LST Range (K)
1	< 285
2	285 ~ 286
3	286 ~ 287
4	287 ~ 288
5	288 ~ 289
6	289 ~ 290
7	290 ~ 291
8	291 ~ 292
9	292 ~ 293
10	293 ~ 294
11	294 ~ 295
12	295 ~ 296
13	296 ~ 297
14	297 ~ 298
15	298 ~ 299
16	299 ~300
17	> 300

Appendix A. Temperature grades for part 4