SPATIAL AND TEMPORAL VARIABILITY IN NDWI AND ITS DRIVING FACTORS IN MONGLOIAN ARCTIC BASIN /2005-2010/

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Abstract

In recent years, the natural overall prospect and component elements have been greatly changed due to the climate warming and other factors. The attitude has been observed that some areas and rivers are drained whereas the amount of areas in some areas is being raised.

By this research work, I aimed to determine the areas changes of river-basin in the Arctic Ocean which is one of the river-basins in Mongolia through utilizing Terra-Modis satellite which has the 8-days frequent and the resolution of 250m and 500m, as well as study how the climate factors such as temperature and precipitation would affect to the areas changes.

During the period of research, the areas of water cover of the river-basins in the Arctic Ocean had been increasing, but it hugely depended on the precipitation and air temperature of the year.

Key words: Water area, NDWI

Introduction

Since the work of observing the water level and flow of rivers started in 1942, the observation, control and examination network had been formed, and now the observation is being made for 108 rivers and 15 lakes. For seeing from the result of the research in the resource of surface water, the resource of surface water hadn't been changed in the last 40-60 years.

The 70 percent of lakes, rivers and water in Mongolia consists of the Altai mountains, Khangai mountains, Khentii mountains, and a rise in the ground of Khuvsgul mountains at the 30 percent of total territory of Mongolia /D.Batmunkh, 2014/

The river-basin of the Arctic Ocean exists in the Northern of Mongolia, and involves the 29.6 percent of total territory. And for seeing the fact that the 52.1 percent of flow for the rivers are involved in the Arctic Ocean, the areas for collecting water is less, and but the surface flow of water networking density is more.

The researches for the climate warming and its affects which are considered throughout worldwide are being made in all of sectors, and a number of researchers have been studying the affect for the surface water and ground water which are the source of the human life.

There is the research for estimating to how the flow of rivers would change when the average air temperature and the precipitation which are the main indicators for the climate change are being changed by the certain amount. And when the air temperature isn't changed and the precipitation is decreased by 10 percent, the average flow of rivers in the Arctic Ocean would be decreased by 12.5 percent. In contrast, when the amount of precipitation isn't changed and the air temperature is increased, the average flow of rivers in Arctic Ocean may be decreased by 4-20 percent. This shows that in the first round of the climate warming, the process that perpetual snow, ice-river and permafrost soil melt down would intensify and increase the flow and the areas of lakes, as well as in further if that continues like this, the rivers flow and the areas of lakes would decrease (УЦУОШГ, 2010).

Materials and Methodology

Study site

The river-basin of the Arctic Ocean contains 315173.4 km squares between from $96^0$53' to $109^0$17'of the eastern longitude and from $46^0$28' to $52^0$9" of the northern longitude in the northern of Mongolia.*(figure1)*The northern part reaches to Tsagaan nuur sum of Khuvgul aimag, the southern part reaches to Uyanga sum of Uvurkhangai aimag, the western part reaches to Ider sum of Zavhan aimag, and the eastern part reaches to Umnudelger sum of Khentii aimag.

The river-basin of the Arctic Ocean contains the back edge of Khangai mountains, the back of Khentii mountains and the vast mountainous between Khuvgul mountains, as well as reaches to the length of 664.2 km from the western to the southern, and reaches to the length of 919.8 km from the western to the eastern.

This river-basin is surrounded by the mountains of Khangai, Khentii and Khuvgul, as well as exists at the height of 1000-1500m in the river-basins and at the height of 2000-3000m in the higher mountains and exists at comparatively higher with other river-basins. The highest point of it is the 3540m of Angarhai mountain at the Khangai mountains.

Although the existing above sea level primarily makes the climate cooler, the higher mountains attract humidity through the air flows, and become moister than the low ground.

These river-basins pour to the Arctic Ocean, however, since it exists far away of 1000km from the Arctic Ocean, has dry climate.

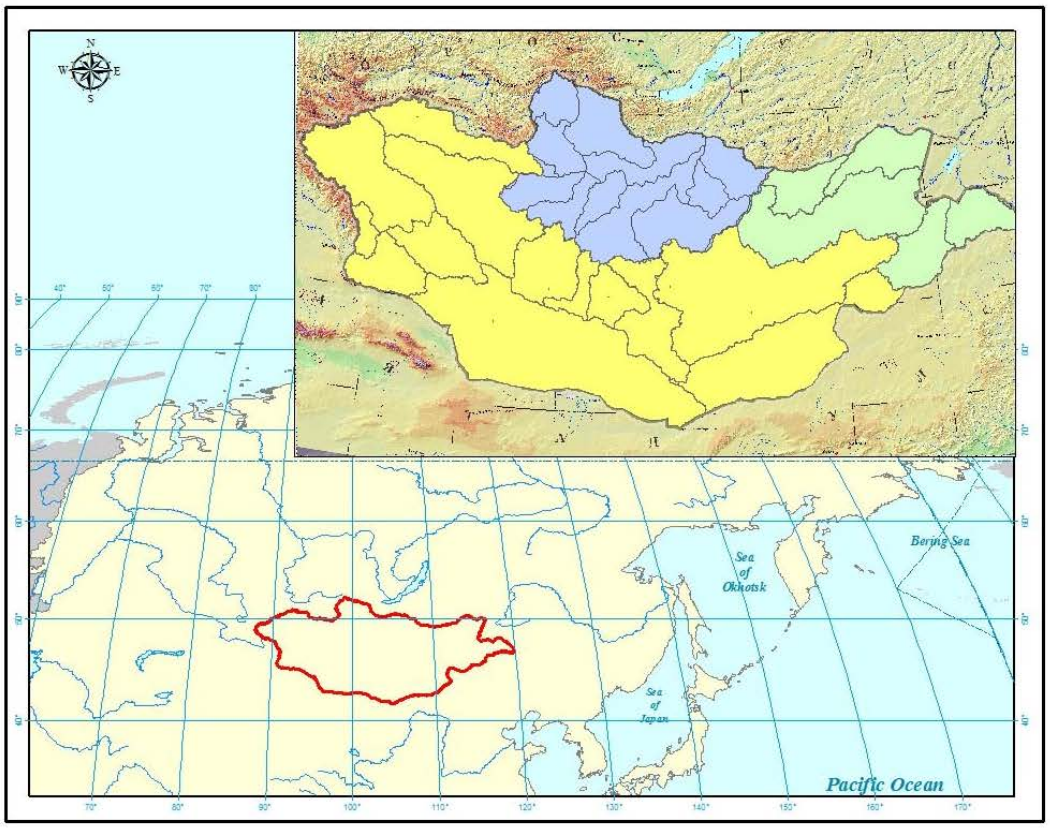

Figure 1. Location of Arctic ocean basin in Mongolia

The fact that climate is dry appropriately reflects on that the characteristic of soil and vegetation cover impacts on the surface and makes them specific. Forests that covered the front and back edge of the mountains at the northern of Mongolia contain the certain amount of areas, as well as most of forests cover the only back edge of the mountains, the steppe plants go around at the front edge to the height of 1000-1300m.

The average air temperature is -2^0C - -8^0C, but is -6^0C and colder at the higher mountains and is -2^0C - 4^0C at the valley areas.

The amount of precipitation of a year is comparatively more than other areas in Mongolia and is 250-500mm, as well as doesn't exceed than 250-350mm at the valley areas because the difference between the mountainous areas and the valley areas strongly comes out.

The tundra and mountain meadows and the permafrost taiga soil dominate at the top of higher mountains whereas the mountain meadow turns into the steppe taiga soil, and meadows

steppe and meadows carbonate black earthen soil would dominate at floodplain of the rivers. Another floodplain soil is at the several river valleys, and the dry steppe and deserted soil go around a bit.

Because this river-basin has the surface with river valleys between the higher mountains and the extreme climate, for the vegetation, the steppe wheat grass, daagan suul and wire grass which have the characteristics of the tundra of the higher mountains, the mountains taiga forests, the steppe forests of the higher mountains, meadows steppe, low mountains and dry and steppe majorly go around, whereas festuca sorts, sheep festuca, red festuca, Siberia festuca and Altai festuca majorly grow.

Materials

In the research, I utilized choosing the data from MODIS satellite with the 8-days frequent and MOD09A1 and MOD09Q1 with the resolution of 250m and 500 m in 2005-2010 in order to estimate the changes of the water areas.

In addition, I utilized the data of the areas of snowy cover that was estimated from the data of the temperature and the precipitation in 19 climate stations which are for the constant measure of climate, and the data of MODIS satellite.

Methods

In determining the areas of water cover, I utilized the NDWI method which was formulated by McFeeters (1996) out of the most suitable methods.

McFeeters estimated NDWI (Normalized Difference Water Index) as the following.

$$NDWI = \frac{(Xgreen - Xnir)}{(Xgreen + Xnir)}$$

And for the satellite, $Xnir$ is the second channel with the wave length of 0,545-0,565 μm for the range of near infrared rays, and $Xgreen$ is the 4th channel with the wave length of 0,841-0,876 μm for the range of visible lights. A value of NDWI is -1.0-ээс +1,0, as well as the negative value is plants and buildings, and the positive value is the areas with water cover.

I processed the first round of development in the data of MODIS satellite, utilizing MRT program, as well as reclassified the picture which made with NDWI method by ArcGis the program arrangement, and accurately produced the water areas.

Result

Water area change

The attitude is being observed that the areas of the river-basins in the Arctic Ocean have been increased. But this increased attitude is not constant, and the areas of lakes have been increased in several years, whereas the areas of lakes have been decreased in other some years.

The areas of lakes was 4018.19 km squares in 2005, whereas was increased to 4330.21 km squares in 2010. *(figure2)*

Due to the affect of a number of factors, a year with the highest growth was 2009-2010 by 18.24 percent (3662.14 km squares in 2009, and 4330.21 km squares in 2010), and a year with the highest drop was 2008-2009 by 10.82 percent (4106.44 km squares in 2008, and 3662.14 km squares in 2009). *(figure3)*

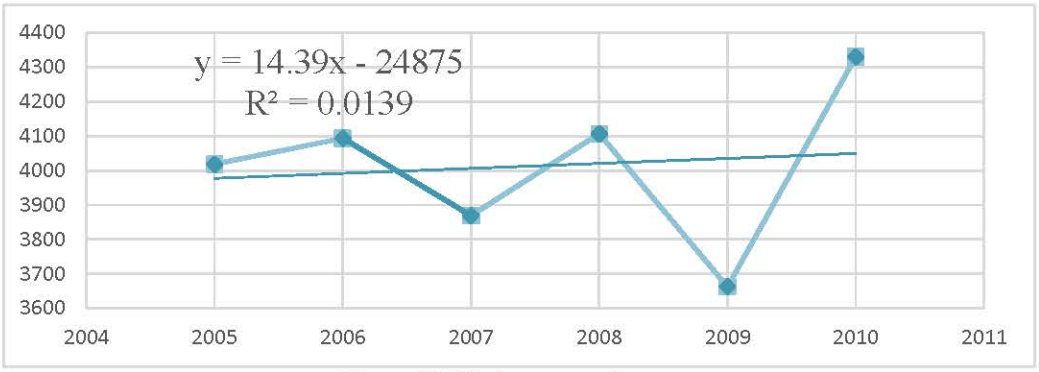

figure 2: Water area change

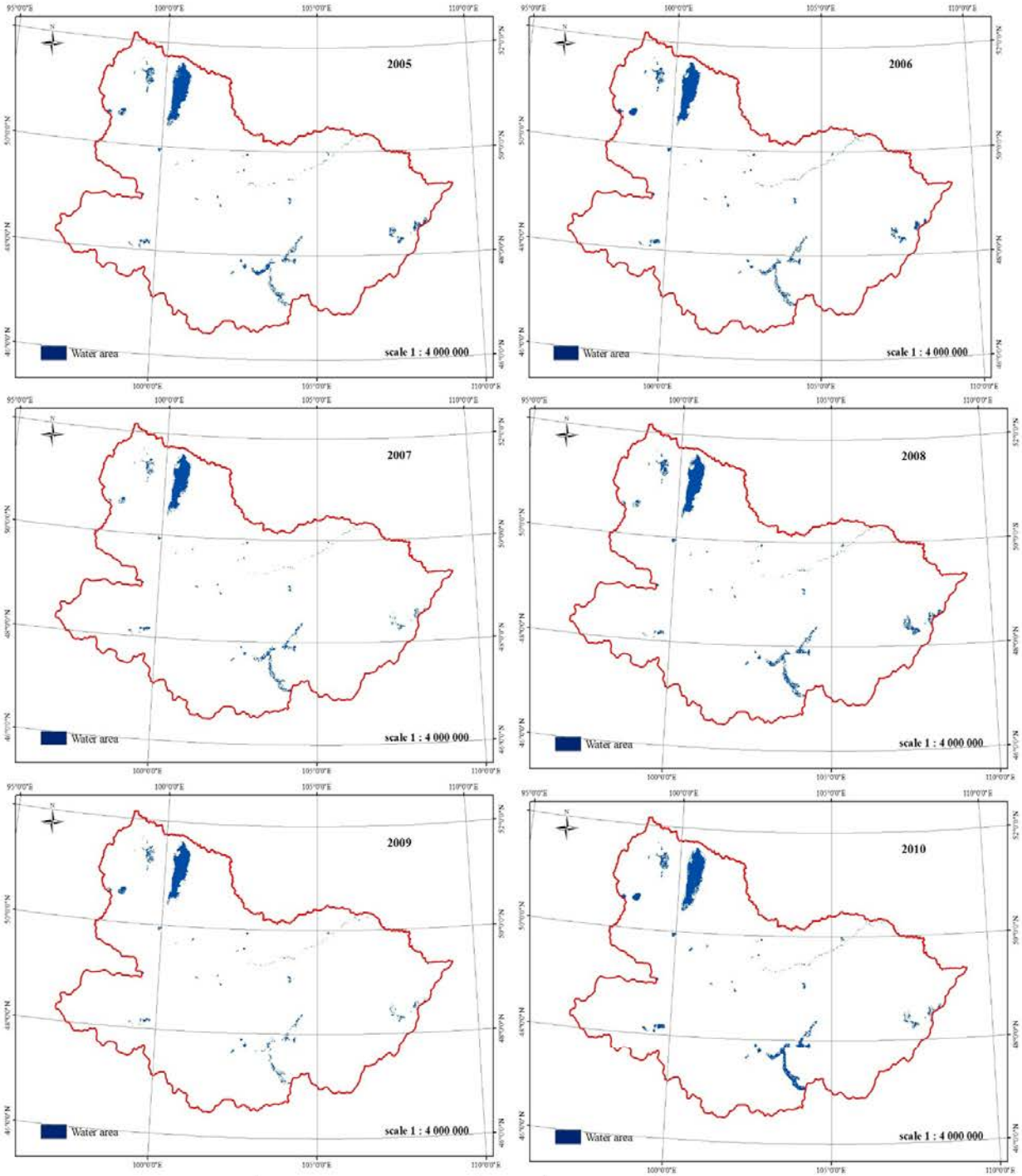

figure 3: Water area change (2005-2010)

Comparisonbetween water areas and precipitation, temperature

The precipitation and the air temperature are the main factors which affect the most importantly to the changes of the water areas of the river-basins in the Arctic Ocean which are surrounded by the higher mountains. The global climate change and the growth of air temperature also were observed at the research areas. The air temperature was averagely increased by 0.5^0C at the warm months which are from May to September in 2005-2010. The growth of air temperature raises the evaporation of lakes, rivers, meadows, the areas with water cover and the humidity areas, as well as in further, becomes the main term to drain.

The amount of precipitation for the water-basin of the Arctic Ocean a year is comparatively higher than other areas of Mongolia, and is 200m and more.

Seeing from the result of the research work, the attitude between the water areas of lakes and the air temperature is negative, and when the air temperature increases, the areas decreases. But the attitude with the amount of precipitation is positive. (*Figure 4)*

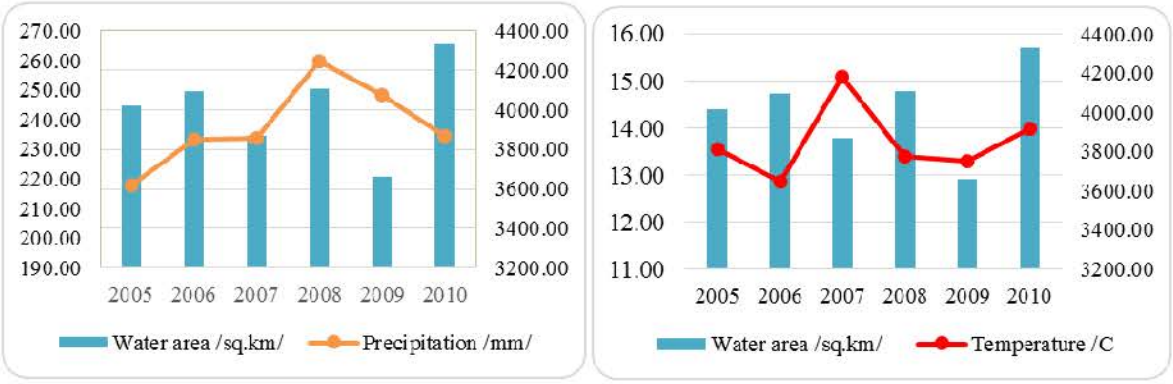

Figure 4: Comparison between water and precipitation, water area and temperature

Conclusion

I produced the changes of water areas of the river-basins in the Arctic Ocean utilizing the data from the MODIS satellite by NDWI the method, and considered the average areas of the appropriate period which is from May to September for clarifying the areas of water cover. In addition, there is possible to study the bigger lakes and the areas of lakes valleys by a year or a month, however, I consider the areas with largely water and humidity such as meadows, muskeg and river valleys as the water cover.

The temperature and the precipitation would relevantly affect at the water areas of lakes, and when the amount of precipitation is constant, the areas of water cover are being changed due to the air temperature change.

The main reason for increasing lake areas is to warm the climate of perpetual snow and permafrost spreading which is the key feature of the research regions, to raise melting of air temperature and to flow through the rivers which take the source.

Not only the precipitation and temperature, but also the areas of know cover, thickness of know, perpetual snow, iced-river, permafrost, settlements of the people and season grazing of the nomads directly and indirectly affect to the areas of water cover of the rivers and lakes, and so these are needed to be considered relevantly.

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