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Austria-Central Asia Centre for GIScience
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Z_GIS

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Connected Regions: Societies, Economies and Environments

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CONTENT

The role of GIS in construction of windmills in Tupkaragan region (Mangystau area)

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Abstract

Wind resources alone are not sufficient to support wind energy development. Neither is the feasibility of a wind energy facility enough to make it sustainable. A GIS for wind energy site suitability analysis must be able to integrate a variety of criteria (including environmental and technical) which can be quantitative as well as qualitative. A GIS is particularly helpful as a decision support tool for locating suitable wind energy development sites where it is able to handle and simulate the physical, economic and environmental constraints.

Keywords: GIS, wind power, windmills, suitable site

1. WIND POWER IN THE WORLD

1.1 Wind is a clean source

Wind is the movement of air from an area of high pressure to an area of low pressure. In fact, wind exists because the sun unevenly heats the surface of the Earth. As hot air rises, cooler air moves in to fill the void. As long as the sun shines, the wind will blow. And as long as the wind blows, people will harness it to power their lives.

Most wind energy comes from turbines that can be as tall as a 20-story building and have three 200-foot-long (60-meter-long) blades. These contraptions look like giant airplane propellers on a stick. The wind spins the blades, which turn a shaft connected to a generator that produces electricity. Other turbines work the same way, but the turbine is on a vertical axis and the blades look like a giant egg beater.

The biggest wind turbines generate enough electricity to supply about 600 homes. Wind farms have tens and sometimes hundreds of these turbines lined up together in particularly windy spots, like along a ridge. Smaller turbines erected in a backyard can produce enough electricity for a single home or small business.

Wind is a clean source of renewable energy that produces no air or water pollution. And since the wind is free, operational costs are nearly zero once a turbine is erected. Mass production and technology advances are making turbines cheaper, and many governments offer tax incentives to spur wind-energy development.

Some people think wind turbines are ugly and complain about the noise the machines make. The slowly rotating blades can also kill birds and bats, but not nearly as many as cars, power lines, and high-rise buildings do. The wind is also variable: If it's not blowing, there's no electricity generated.

Nevertheless, the wind energy industry is booming. Globally, generation more than quadrupled between 2000 and 2006. At the end of last year, global capacity was more than 70,000 megawatts /1/.

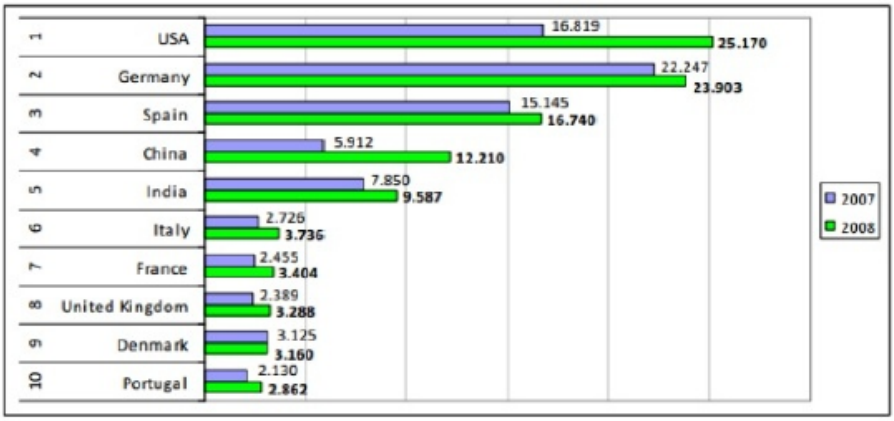
Demand for wind energy is rising rapidly. More and more people are signing up for electricity from renewable sources. We urgently need to build new wind farms to meet this rising demand. Finding suitable sites for new wind farms is no easy task. There are many

locational factors to consider. Designating areas of suitability for wind energy developments enhances implementation and promotes integration with other land uses. Environmental and spatial issues can be addressed early in the siting process by introducing them strategically at the regional level. Geographic Information Systems(GIS) are a useful tool in identifying areas suitable for wind energy development as GIS can draw together and analyse data from disparate sources.

The implementation of criteria (including technical and environmental) for the identification of areas suitable to the establishment of wind energy facilities is likely to promote greater pursuance of wind energy development in those regions while balancing national interests of promoting alternative energy generation with local strategic environmental objectives. This will also avoid conflict between local, national and other interest groups through an integrated environmental planning process /2/.

Table 1 **Top Ten Countries for Installed MW of Wind Energy**

Source: WWEA, 2009



Source: Brigit Helga Editha Moiloa (GIS for Strategic Wind Energy Site Selection. – dissertation for master degree)

2. USING GIS IN WIND ENERGY

2.1 Criteria for suitable site and using it for local site

Using GIS it`s possible to choose more suitable site for windmills` construction:

- Availability of land
- Suitability of wind conditions
- Distance from local settlements
- Distance from protected areas
- Ease of access

lists the following environmental and technical considerations as initial criteria for assessm ents:

I Environmental considerations:

- Visual Aspect
- Proximity to dwellings
- Ecology
- Archaeological/historical heritage
- Recreational uses (of surrounding land)
- Telecommunications
- Civil and military airports
- Restricted areas

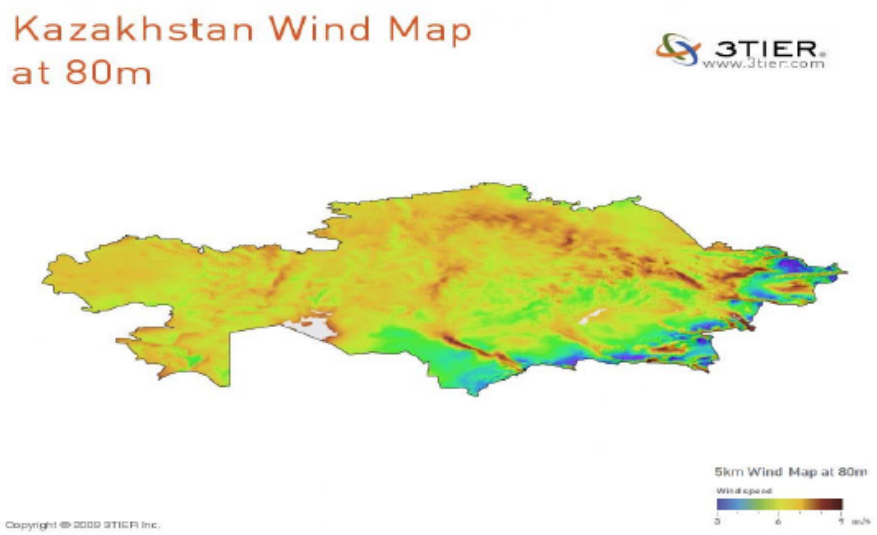
II Technical considerations:

- Wind resource
- Existing land uses
- Ground conditions
- Site access
- Electrical connection
- Draft project design including scale, layout and turbine size

The above mentioned criteria were selected based on the associated impacts of wind energy developments. In general, the environmental criteria include environmental and lands cape sensitivity (visual impact, noise, flora and fauna, heritage sites, etc), planning restriction s and public opinion, whereas the technical criteria generally include wind speed, topography conducive to wind velocity, access to the grid and road accessibility /3/.

Using all these GIS information we will make map for windmills in research area. According to experts, there are at least 10 regions with big wind potential in Kazakhstan, where average rate of a wind makes 8-10 m/s, when the European wind station work in case of average rate of a wind of 4-5 m/s. Are most known: Zhongar Gate, Shelek place, Ereimentau, Fort-Shevchenko, Kordai.

Figure 1: Kazakhstan Wind Map



Source: /http://ws2-23.myloadspring.com/sites/renew/countries/kazakhstan/profile.aspx/

2.2 Mapping Tupkaragan region

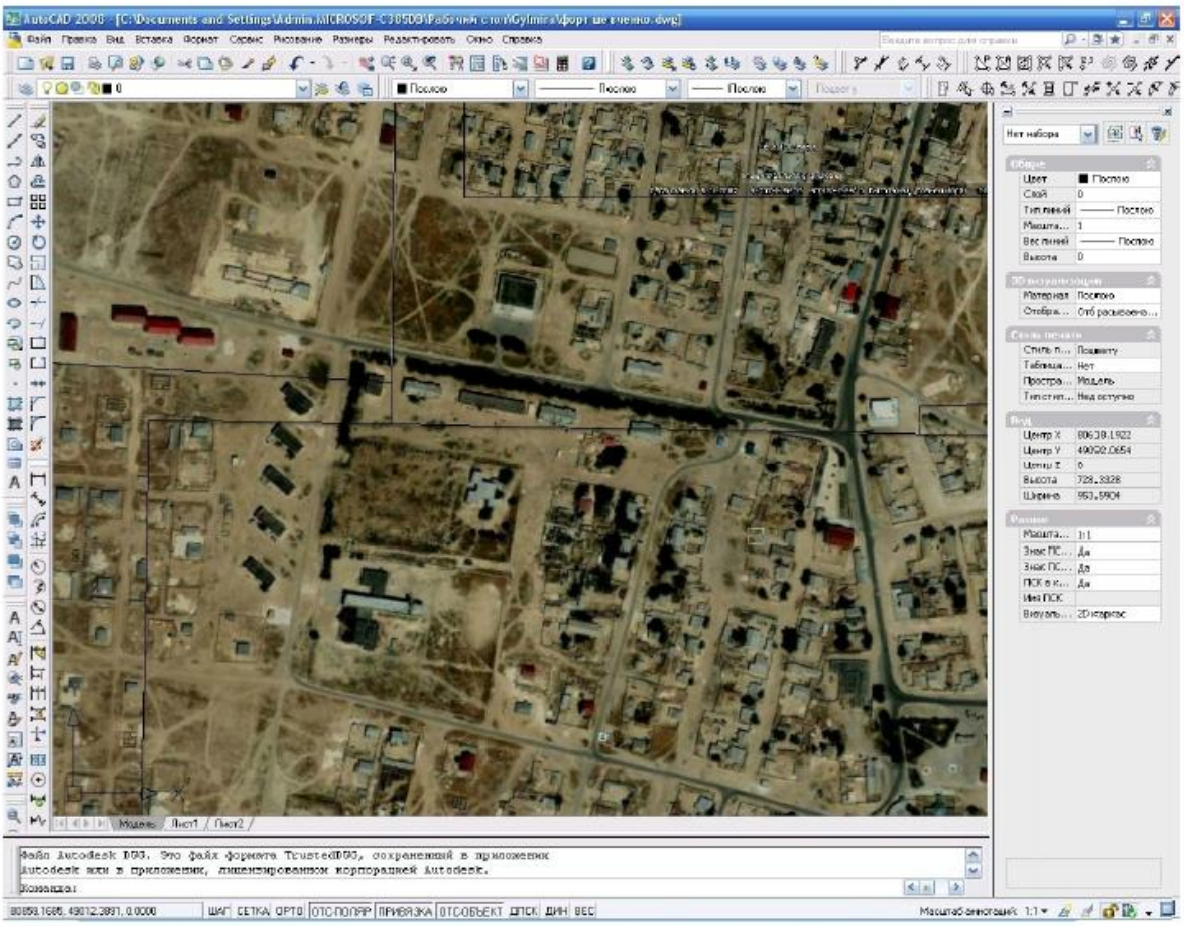
The increased wind speed, not so cold winter and a deficit of electro energy does the Tupkaragan region by important object under windmills construction. The construction will start with local geodetic works and aspects of making maps. The topographical maps of this region are very old, so they need up-dating works. The site under construction of Wind Energy Station (WES) is located on a coastal height of the Tupkaragan peninsula at distance of 10 km to the southwest from the city Fort Shevchenko and identified in case of terrain survey under WES construction. The coast of the Caspian Sea in the region Fort Shevchenko low with an equal surface on kilometre stretch deep into peninsulas, and then sharply passes to a plane plateau in height from 60-70 m above sea level. The site under WES has the sizes 3 x 4 of km and now is free for WES construction in capacity from 20 to

50 MWt. Advantage of this site is absolutely plane relief with absence of trees, buildings or other natural or artificial hindrances to a wind /4/.

Near the researching area lies highway, connecting Fort Shevchenko to Aktau, regional center of Mangystau. The power line (LEP) 110 kW lies on the northwest to the southeast on 1 km distance from researching area.

The area near the town Fort Shevchenko is suitable for construction wind energy stations. The area is free for use and has good wind potential with average long-term rate about 8,5 m/s at height of 80 m. The utilization coefficient of the set capacity of turbines can make about 41,5-42,5 %. Annual volume of production of the electric power from WES in capacity 19,5 MWt will make an order 72 598,5 of MWt/h that is enough for a covering needs of the Tupkaragan region for the electric power on perspective. There are possibilities for extension of capacity of WES. Region is located nearby from power lines, there are delivery ways equipment. Building the wind turbines near Fort Shevchenko could work out the electric power at very acceptable price. The approximate price on from WES about 14 tenges/kWh can make the electric power for supports of internal norm of profitability of the project at level of 9,5 % /5/.

Figure 2: Mapping of Tupkaragan region in AutoCAD program



The main purpose is to find suitable site for construction wind turbines and the aim is solved. Mapping the research area is still on the process. Visibility analysis, using GIS software, highlights those areas on a map from which the wind turbines would be visible. The visibility map depicts the viewshed of the surface from a particular point and includes all

points on the surface that are visible by direct line of sight from observation point, and vice versa.

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