

## ИСПОЛЬЗОВАНИЕ 3D ПРЕДСТАВЛЕНИЯ ОБЪЕКТОВ В ГИС МОДЕЛИ

### Use 3d representation of objects in the gis models

*Учурда геоинформациялык технология адам ишмердүүлүгүнүн бардык тармактарында пайдаланылып жатат, бирок эки кырдуу моделдер кеңири пайдаланылат. Үч кырдуу моделдөө изилденип жаткан жерди, дүйнөнүн объектилерин жана алардын өз ара карым-катышын абдан жакшы сүрөттөп берет. Жүргүзүлгөн анализ көрсөткөндөй, 3D моделдин графикалык сүрөттөлүшү маалыматты абдан ыңгайлуу жана табигый мүнөздө алдыга тартат, бул чечим кабыл алууда сапатка жана натыйжага жакшы таасирин тийгизет.*

**Ачык сөздөр:** геоинформациялык технологиялар, 3D моделдер, жердин рельефи, ГИС.

*В настоящее время геоинформационная технология используется во всех сферах человеческой деятельности, но наиболее широко используются классические двумерные модели. Трехмерное моделирование позволяет наилучшим образом описать реальную местность, объекты мира и их взаимное расположение. Проведенный анализ показывает, что графическое представление 3D моделей объектов представляет информацию в наиболее удобной и естественной форме для человека, который оказывает положительное влияние на качество и эффективность принятия решений.*

**Ключевые слова:** геоинформационные технологии, 3D-модели, рельеф местности, ГИС.

*Currently geoinformation technology is used in all spheres of human activity, but mainly the two-dimensional models are used. Three-dimensional modeling allows to describe the real terrain, objects of the world and their mutual location in the best way. The analysis shows that graphical representation of the control objects in the 3D-models presents information in the most convenient and natural form for a person that has a positive effect on the quality and efficiency of decision-making.*

**Keywords:** Geoinformation technology, 3D-model, terrain model, GIS.

## 1. Introduction

### 1.1 What different between 3D and 2D models?

Any point of the sheet defined by the two values. There are «x» - horizontally and «y» - vertical. Therefore, the object in two-dimensional (2D) space, looks like as a "flat", and is not realistic. So that the image was looks three-dimensional, you must enter a third dimension - height (z). In three-dimensional (3D) space, each point is defined by three values. From the programmer's perspective, a point - a record, which consisting of three components: x, y, z. More then, {x, y, z} are the vector defining of point. Thus, we can create a whole array of points with their coordinates, with which we shall describe the objects.

## 1.2 Appointment of three-dimensional terrain models

3D-modeling is the process of creating three-dimensional object model. The main function of 3D-modeling is to develop a visual image of the desired volume of the object. With three-dimensional graphics you can create a correct copy of a specific subject, and to develop new idea of unreal object.

3D-modeling allows the best way to describe the real terrain, the objects of the world and their mutual arrangement.

Three-dimensional models are full three-dimensional maps which allow selecting objects in the model in order to request information about the object, to edit their appearance and characteristics (semantics), to determine the coordinates of objects, to perform measurement and settlement operations, to make a detailed assessment of the area in laboratory conditions.

The technology of constructing three-dimensional model is designed to create three-dimensional models of varying degrees of detail and applied tasks.

The model can be a variety of maps. There are plans of cities, space and aerial photos, large-scale maps, raster images and other materials. They can be used both separately and together.

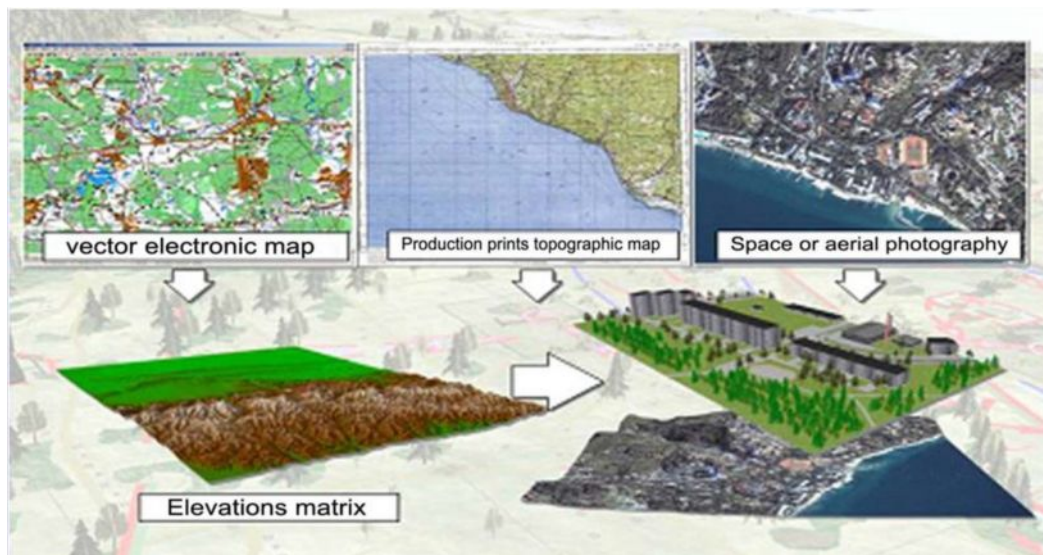


Figure1. Some kinds of maps

## 1.3 Types of three-dimensional terrain models

There are following types of model of the level of detail:

### Typical three-dimensional models

Typical three-dimensional models are created according to the plans of cities, topographic maps or the overview map. Typical models include the surface of the terrain, buildings, road network facilities, pipelines, wells, traffic lights, vegetation's objects, hydrography and other objects of simple shape.

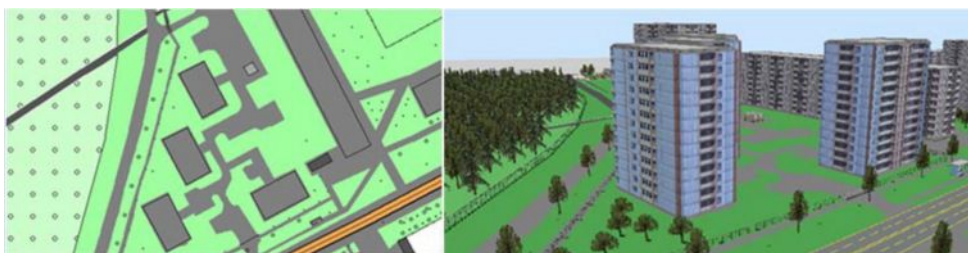


Figure 2. Typical three-dimensional models: City plan, typical three-dimensional model of the city

Construction of the typical model is the fastest way to get high-quality three-dimensional terrain models. Typical models can be used for the visual evaluation of the mutual arrangement of objects taking into account features of the terrain and altitude, analysis of mutual location of electric cables and pipelines of different functions.

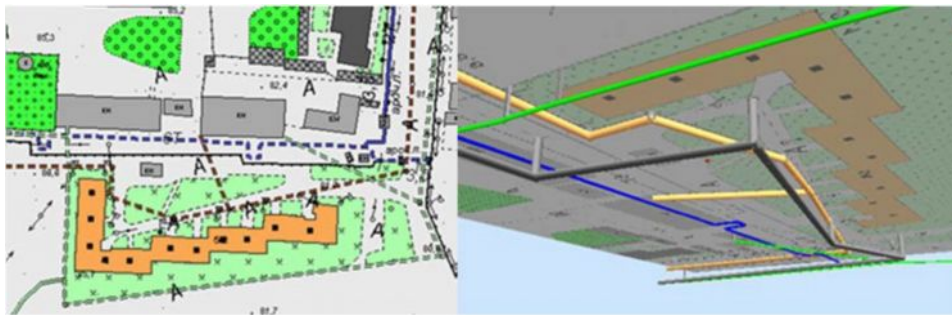


Figure 3. Typical three-dimensional models: City plan, typical three-dimensional model of the pipeline

#### Three-dimensional models detailed view

Three-dimensional models detailed view describing the terrain with the objects, the form of which can be adjusted individually, and can be created according to the plans of cities. The models contain surface detail view of the terrain, typical objects, which size of three-dimensional image of which is close to their actual size on the ground (architectural structures with porches, chimneys, elevator towers, and other design elements.).

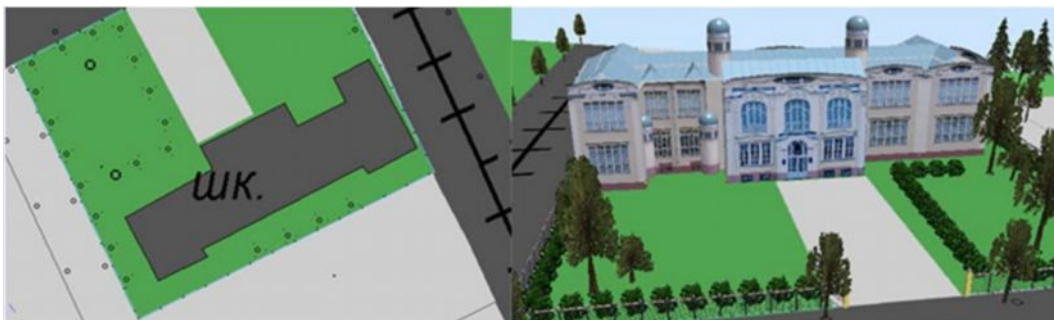


Figure 4. Three-dimensional models detailed view: City plan, typical three-dimensional model of the school

#### Three-dimensional model of the interior

Three-dimensional models allow us to describe the interior view of the building and are based on floor plans.

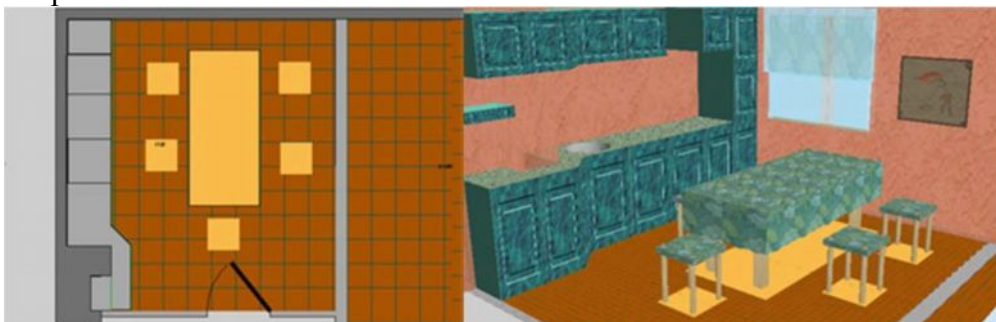


Figure 5. Three-dimensional model of the interior: Floor plan, three-dimensional model of the kitchen

### **Thematic models**

Thematic models are created for thematic maps and are used for processing of statistic charts. One example of the use of technology to build mathematical model may be to create three-dimensional models of individual urban objects.



Figure 5. Three-dimensional model of the thematic models:  
model of the cottage, model of the street

## **2. The use of 3D in different spheres of human activity**

Have some activities, which used the different map, there are electronic, paper, or at least presented in the mind - are indispensable. Much business cannot be started, without knowing beforehand WHERE there is a point of our efforts. Even in everyday life we are hourly and sometimes even every minute working with information about the geographical location of objects: shop, kindergarten, subway, work, school ... Spatial thinking is natural for our minds.

The following are some areas of human activity, in which 3D models are or may become an integral part of the work:

### **Construction of roads and housing**

These objects construction involves the implementation of a set of measures: surveying services and project takeaway on the terrain, excavation, laying several layers of pavement, drainage equipment and drainage systems, etc. Many of the stages are very long and time consuming, and require the participation of a large number of skilled professionals.

3D-systems provide a higher level of automation of the construction process. In the traditional approach, builders get the raw data in the form of drawings plan, longitudinal and transverse profiles, statements, bills, and so forth. Restoring the surface of three-dimensional models to these data is very difficult and requires a lot of time and effort, but the visual representation of the construction reduces the number of days for the production, as well as unforeseen costs.

### **Creation potentially dangerous objects in 3D-models for the needs of the Ministry of Emergency Situations**

Emergency occurs suddenly and spontaneously develops. People must act quickly and accurately. To carry out the rescue and other emergency operations in the aftermath of Ministry of Emergency staff need timely information about the layout of the object and the surrounding area.

With 3D-model of a potentially dangerous object, you can estimate the zone of destruction possible, to model itself emergencies; and to develop measures of prevention and liquidation of emergency plan, in relation to this particular object.

Three-dimensional modeling allows you to monitor the status of control of objects and their technological systems. It reduces the risk of disaster.

On the potentially dangerous objects 3D-modeling can be used for distance learning Ministry of Emergency Situations staff and company personnel measures to prevent, eliminate and evaluation of consequences of emergency situations.

#### 3D-models in Military topography

Military surveyors develop 3D-models of polygons, which will be international and local exercises. Creating these models ranges will allow the organizers to distribute the units more effective on the ground and assess the unfolding situation in the exercises. Also, 3D-technology application is not new to the military. In many countries, there are several sets of simulators that allow simulating combat, in which each participant sees not only his technique but also the environment; and a main commander on the simulator sees the situation as a whole, and can evaluate the performance of each crew in particular.

#### The use of 3D technology for the restoration of monuments of history and architecture

Wooden structures (fortress, built in) are particularly exposed to the time they were built quickly, to perform its function, and just as quickly collapsed. Reconstruction of monuments of culture becomes the only way to restore them. Simple text description cannot give the researcher the most complete picture of the object being studied. Photography, drawing, drawing, map contain visual information, but each data type has its own characteristics and weaknesses.

#### 3D-models in policy and fire station

These groups are merged into one, so that the use of the 3d technologies in these areas carries almost the exact same role:

- Lost in the form of a virtual design and substantive fullness of burnt object / crime scene
- The cause of the fire / find clues, hidden previously by human eyes

#### Medical service

The world's leading medical clinics in recent years, there tend to demonstrate the principle of operation. Modern technology of 3D-graphics and animation can clearly and conditionally (without blood picture and other things that cause most people dislike) show the patient treatment process. Such videos are used for training of interns and medical students.

The teachers of medical schools can use three-dimensional graphics in vivid teaching methods to demonstrate the equipment, technical installations, as well as all sorts of physiological processes such as blood flow through the vessels, the formation of cholesterol plaques, the multiplication of viruses, the process of giving birth, etc.

#### And etc.

A graphical representation of the control objects in the form of 3D-models presents information in the most convenient and natural for a person that has a positive effect on the quality and efficiency of decision-making. This property of 3D-models can be widely used in the creation of territories of situational control centers (crisis centers, online services, to monitor the use of bio-resources departments, accounting and control of real estate, and so on. D.).

### **3. Using a digital elevation model in 3D GIS models**

Currently, the GIS have found their wide application and demand. GIS are designed to solve scientific and applied problems of analysis, assessment, prediction and management of the environment and territorial organization of society. And also for the collection, storage, analysis and graphical visualization of spatial data and related information presented in a GIS objects. In other words, a tool that allows users to search for, analyze and edit digital maps, as well as additional information about the objects, such as building height, address, number of occupants.

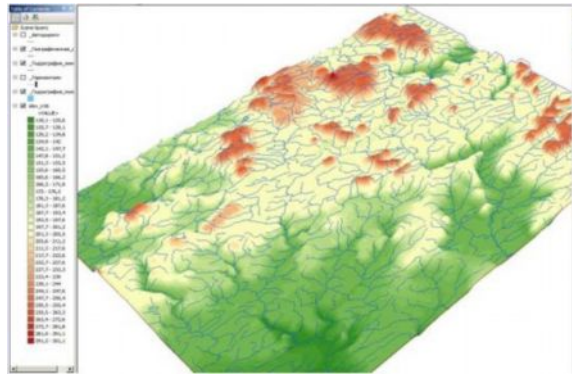


Figure 6. Three-dimensional model of terrain with rivers

Today, no one disputes the importance and value of cartography, as well as the importance of its effective use. When mapping spent a lot of effort to receive and process the required information. You need to make this information work for them so that they were able to recoup the money spent on their production.

Modern GIS tools allow access to spatial information, analyze it properly; consider all the processing algorithms. GIS helps to better manage projects. It provides cost-effective and efficient tools to meet the ever-increasing needs of the market in services in the field of geodesy and cartography, without any delay. GIS-based solutions help to increase your competitiveness in the market of high technology and information services. Infrastructure Design and development respective project engineering training and development of the territory is also required at the moment of automation and the use of appropriate GIS.



Figure 7. Realistic three-dimensional model of terrain

Specialists to require software solutions for the design of building structures and buildings, to simulate land topography, topographic analysis of the area to assess the environmental measures to create a coherent geometric model. For the development of such projects requires not only the art of designers, but also surveyors, town planners, surveyors, civil, structural engineers, environmental specialists and cartographers.

A digital terrain model (DTM) is a means of representation of the topographic (earth's) surface by computer processing of the results of geodetic surveys. With the help of a digital elevation model solved applied problems such as the construction of contour lines, obtaining longitudinal and transverse profiles, calculation of volumes of earth masses, etc. The processes of surface modeling are important not only for prospectors. For example, when designing master plans, designers using 3D digital model of the existing topography solve the problem of calculation and optimization of volumes of transported soil. And for the successful and effective implementation of established projects such as the master plan or the project of the road, you must submit a design solution in the form of 3D digital terrain model of the projected surface because

such data are important for the operation of automatic control systems of construction equipment. Therefore, the task of creating and using digital models of surfaces are not only before prospectors but also to the designers and the builders.

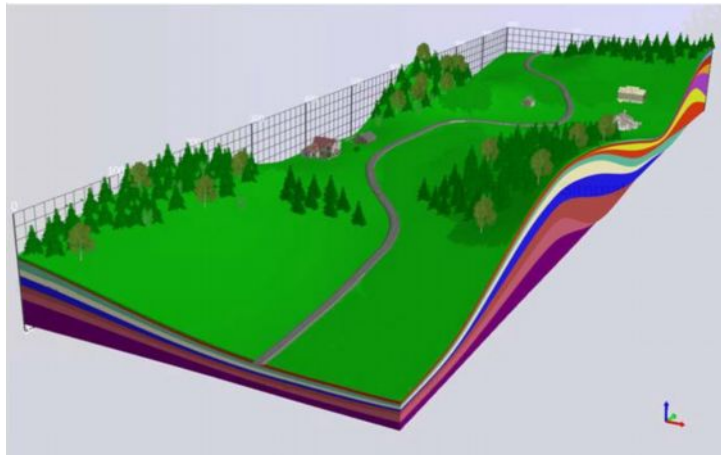


Figure 7. Detailing three-dimensional model of terrain

Analyzing the above, we can identify the most important areas of application of DEM (but this list is not exhaustive):

1. Creating predictive spatial models, taking into account the characteristic features of the landscape;
2. Calculation of geometric characteristics (area, length, perimeter) with regard to the relief needs of architecture and urban planning, engineering, surveying, mapping, navigation;
3. Calculation of the steep slopes, the monitoring and forecasting of geological and hydrological processes, for example, areas of flooding floodwater to Ministry of Emergency or erosion of fertile topsoil for agriculture and more;
4. Calculation of illumination and wind conditions for architecture and urban planning, engineering studies, environmental monitoring;
5. Construction of the visibility zones for telecommunication and cellular companies, architecture and urban planning;
6. Visualization for the design of roads, power lines, oil and gas pipelines, inventory management and engineering services, and so on. D.
7. Orto-transformation materials aerial and satellite imagery;
8. Develop attributive and geometric characteristics when creating and updating digital topographic maps.

#### 4. Conclusion

In conclusion, I would be noted that the three-dimensional model provides a more detailed and objective information on each object and the territory, as well as allows solving several problems of different services:

- Visualizing spatial information in a three-dimensional models in a single coordinate system: terrain, infrastructure, communication, construction, installation, technological equipment, which can be used to optimize processes, to plan and to create favorable conditions for the transport and logistics operations, correct design decisions.
- To develop projects, such as design, and projects of reconstruction, restoration, repair, and (re)planning strategically and functionally important sites, as well as maintenance of equipment (lighting, electricity, etc.).
- Conduct tests, does means obtain reliable information on the actual situation of infrastructure, building elements and communications buildings and premises that determines the optimal approach to performance management.

- Information on the actual status and capabilities of the infrastructure necessary for the assessment and validation of the planned business - projects and attract additional investments.
- Provide data for the planning and organization of activities for the prevention and elimination of emergency situations, the development of labor protection measures, the calculation is to determine the most effective working areas.
- To solve the problem of data public utilities, ensuring accurate geometrical parameters on which the actual distance between the elements and their actual dimensions will be reflected; make maps (plans) for surveying the land objects.
- Perform inventory and accounting of objects, buildings and areas, allowing more accurate calculation of economic efficiency and improve the quality of property management. It also allows more accurate calculation of the residual, reducing the cost of servicing buildings and structures.
- Use the finding data in the future, by applying to the objects of thematic information and the development of the knowledge base, as well as the creation of GIS by building the knowledge base.

### References

- Gusev, IA, Ivlieva NG On the experience of integration of three-dimensional computer simulation and GIS // Geodesy and Cartography in the modern world: Materials of the 2nd Proc. scientific-practical. Conf., Saransk, April 8. 2014 - Saransk: Publishing House of the muzzle. Ounces that. - 2014. - P. 193-197.
- Grechishchev, A. Three-dimensional modeling and photorealistic rendering urban areas/ A. Grechishchev V. Baranichenko, S. Convents, A. Spielman/ArcReview.-2003- №2 C. - 12-13.
- Vorobiev, YD Construction of three-dimensional model on the basis of the cadastral information [Text] / YD Vorobiev, EN Lanin, DI Babanov // Geodesy and Cartography - 2004. - number 3 - C - 43-52.
- Google Earth [electronic resource]:  
Access: <http://www.softportal.com/freesoftware/3943/google-earth>
- Review of software for three-dimensional modeling and animation [Electronic resource]: Access: [http://www.ci.ru/inform15\\_03/p\\_08.htm](http://www.ci.ru/inform15_03/p_08.htm)
- Matossyan, M 3DS Max 6 for Windows [Text]: Per. with English / M. Matossyan. - M.: DMK Press, 2004. - 624 p.
- Ivlieva NG, Manukhov VF Integration of 3D-modeling and GIS // Scientific works KubGTU: Mat-ly XX Intern. scientific-practical. Conf. "Innovative processes in higher education "[Electronic resource]. - 2014. - № 4. - Access: <http://ntk.kubstu.ru/>.
- Lazerko MM Shemanovsky OA Simulation "infill development"three-dimensional objects of the urban area based on aerospace shooting using design in AUTOCAD [Text] / MM Lazerko, OA Shemanovsky // Geodesy and aerial photography. - 2010. - number 1 - C - 20-23.
- Yutaka TAKASE, Atsushi SONE, Tatsuya HATANAKA, Mamoru SHIROKI, Takamitsu MASUMI, 2005. A Development of 3D urban information system on web. International Workshop on "Processing and Visualization using High-Resolution Images", Pitsanulok, Thailand, ISPRS Commission VI, WG V / 6.
- Takase, Y., Sho, N., Sone, A., Shimiya, K., 2003. Automatic Generation of 3-D City Models and Related Applications, International Workshop on Visualization and Animation of Reality-based 3D Models, Tarasp-Vulpera, Switzerland, ISPRS Commission V, WG V / 6.
- Wikipedia [electronic resource]: Access: <http://wikipedia.ru/>



Zhulin MA, A. Karasev, Manukhov VF Use of information technologies in the design and implementation of the tourism product // Geodesy and cartography. - 2013. - № 2. - S. 32-36.