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**IMPLEMENTATION OF METHODS FOR MAPPING AREAS OF FLOODING  
WITH THE MELTING WATERS OF THE ESIL RIVER**

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**ЕСІЛ ӨЗЕНІНІҢ ЕРІГЕН СУЛАРЫМЕН СУ ТАСУ УЧАСКЕЛЕРІН КАРТАҒА  
ТҮСІРУ ӘДІСТЕРІН ЕНГІЗУ**

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**РЕАЛИЗАЦИЯ МЕТОДОВ ПОСТРОЕНИЯ КАРТ ЗОН ПОДТОПЛЕНИЯ  
ТАЛЫМИ ВОДАМИ РЕКИ ЕСИЛЬ**

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**Abstract**

The problem of flooding with the thawed waters of the Esil River is an extremely important task and requires special attention, since the late evacuation of the population can lead to death. In recent years, there has been a spill of the Esil River before the expected date, which causes damage to human settlements and damage to agriculture, subsequently increasing financial losses. There is a need to develop new methods for studying the terrain in flooded areas, so that these methods allow us to see a more accurate picture of the alleged flooding before the onset of an emergency situation, with the possibility of preventing the consequences of: human, financial, agricultural losses. For a more accurate forecasting, the use of Agisoft PhotoScan, GIS Sputnik software is proposed to build detailed altitudinal mapping of flood zones with the melting waters of the Esil River.

**Key words:** flooding zones, Esil river, flood situation, Agisoft PhotoScan, GIS Sputnik, Dolmatovo.

**Аңдатпа**

Есіл өзенінің суының ағып кету проблемасы аса маңызды міндет болып табылады және ерекше назар аударуды қажет етеді, өйткені халықты кешіктірген эвакуациялау өлімге әкелуі мүмкін. Соңғы жылдары Есіл өзенінің күтілетін мерзімге дейін төгілуі орын алды, бұл елді мекендерге зиян келтіріп, ауыл шаруашылығына зиян келтіріп, кейін қаржылық шығындарды көбейтеді. Су тасқынынан зардап шеккен аудандардағы жерді зерттеудің жаңа әдістерін әзірлеу қажеттілігі туындады, сондықтан бұл әдістер төтенше жағдайдың басталуына дейін болжамды су тасқыны туралы нақты көріністі көруге мүмкіндік береді, бұл адамның, қаржының, ауыл шаруашылығының шығындарының алдын алу мүмкіндігін береді. Неғұрлым дәл болжау үшін, Agisoft PhotoScan, GIS Sputnik бағдарламалық қамтамасыз етуді су тасқыны аймақтарын Есіл өзенінің балку суларымен егжей – тегжейлі биіктік картамен құру ұсынылады.

**Түйінді сөздер:** су тасқынынан зардап шеккен аймақтар, Есіл өзені, су тасқыны жағдайлары, Agisoft PhotoScan, GIS Sputnik, Долматово.

**Аннотация**

Проблема подтопления талыми водами реки Есиль является крайне важной задачей и требует особого внимания, так как несвоевременная эвакуация населения может привести к гибели людей. Последние годы наблюдается разлив реки Есиль ранее ожидаемого срока, который приносит ущерб населенным пунктам и урон сельскому хозяйству, впоследствии увеличивая финансовые потери. Возникает необходимость разработки новых методов исследования рельефа местности в затопляемых зонах, чтобы эти методы позволили увидеть более точную картину предполагаемого подтопления до

наступления чрезвычайной ситуации, с возможностью предупреждения последствий: человеческих, финансовых, сельско – хозяйственных потерь. Для более точного прогнозирования предлагается использование программ Agisoft PhotoScan, ГИС Спутник, для построения подробного высотного картирования зон подтопления талыми водами реки Есиль.

**Ключевые слова:** зоны подтопления, река Есиль, паводковая ситуация, Agisoft PhotoScan, ГИС Спутник, Долматово.

### **Introduction**

The flood situation in the North Kazakhstan region requires special attention. According to the Department of Emergency Situations, in the region, 36 settlements are exposed to flooding from a high level of rivers, 41 settlements from meltwater and 15 settlements to a floodwater level in lakes. In Petropavlovsk, flooding is caused by the melting of snow. Several microdistricts of the city, such as Podgora, Kopai, Kozhzavod, Rabochiy settlement, Benzostroy, Zarechny settlement, are subject to flooding from thawed surface water. The latter is also susceptible to flooding when the Esil River overflows [1].

Analyzing the flood situation from the reports of the Committee for Emergency Situations of the Ministry of Internal Affairs of the Republic of Kazakhstan, reports of rescue services in the media, you encounter a reference to the unpredictable course of water. In 2019, the North Kazakhstan region, the water went through the crest of the dam of the Sergeevsky reservoir almost 15 days earlier than last year [3].

In this regard, it is important to anticipate in advance the flood situation, assess the areas of the spill, promptly warn the population, prevent possible damage by direct intervention of the services.

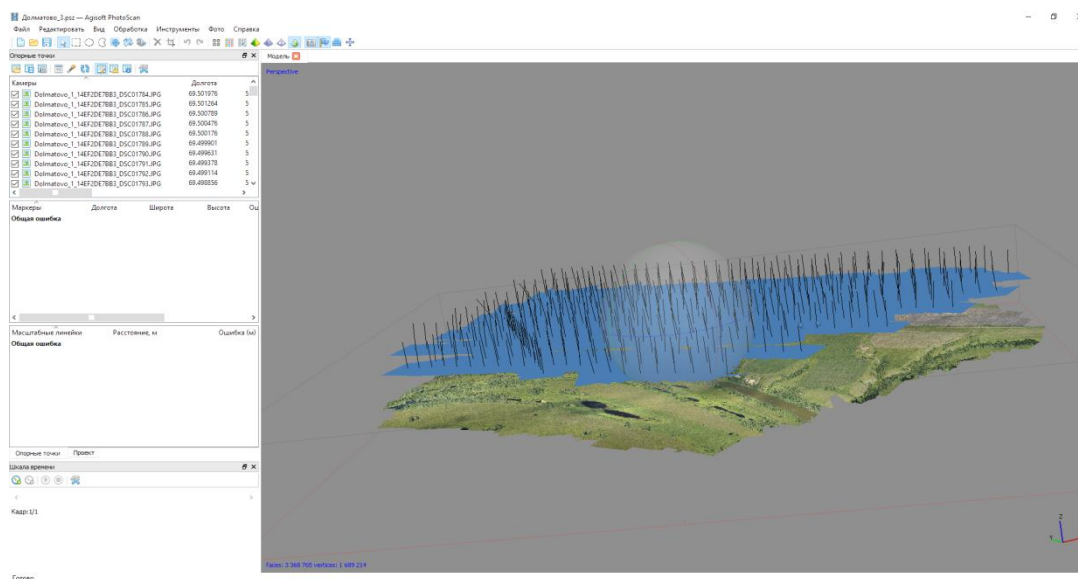
At the Department of Physics, analytical and software work is done to assess the flood situation in the DIS, ranging from assessing the extent of snow cover to direct forecasting of flood water through the territories. Using Agisoft PhotoScan, you can build a map of the height of the terrain. The program Agisoft PhotoScan implemented a modern technology to create three – dimensional high – quality models based on photogrammetry methods. To reconstruct the 3D model of an object, Agisoft PhotoScan allows you to use photographs taken by any digital cameras from any angle. For models with a given scale, Agisoft PhotoScan also allows you to measure distances and calculate surface area and volume. The model is scaled based on preliminary measurements within the reconstructed scene [four].

The previously filmed material was processed and analyzed with the help of the unmanned aerial vehicle GEOSCAN – 101.

Stages of building a height map: photo alignment; building a dense cloud of points; building a three – dimensional polygonal model; texturing an object; building a tile model, building a digital terrain model; building an orthophotomap; export results.

Below is an example of the implementation of the Yesil river flooding in the Dolmatovo area.

The first is the construction of a 3D landscape map of the area using the program Agisoft PhotoScan.

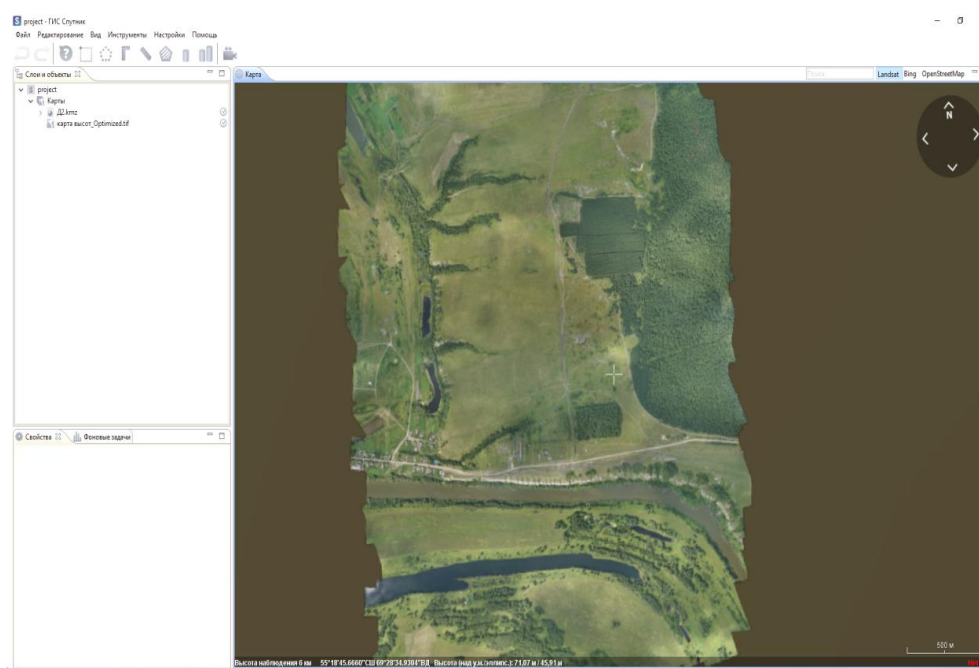


Picture 1 3D terrain model from the village of Dolmatovo in the program Agisoft PhotoScan

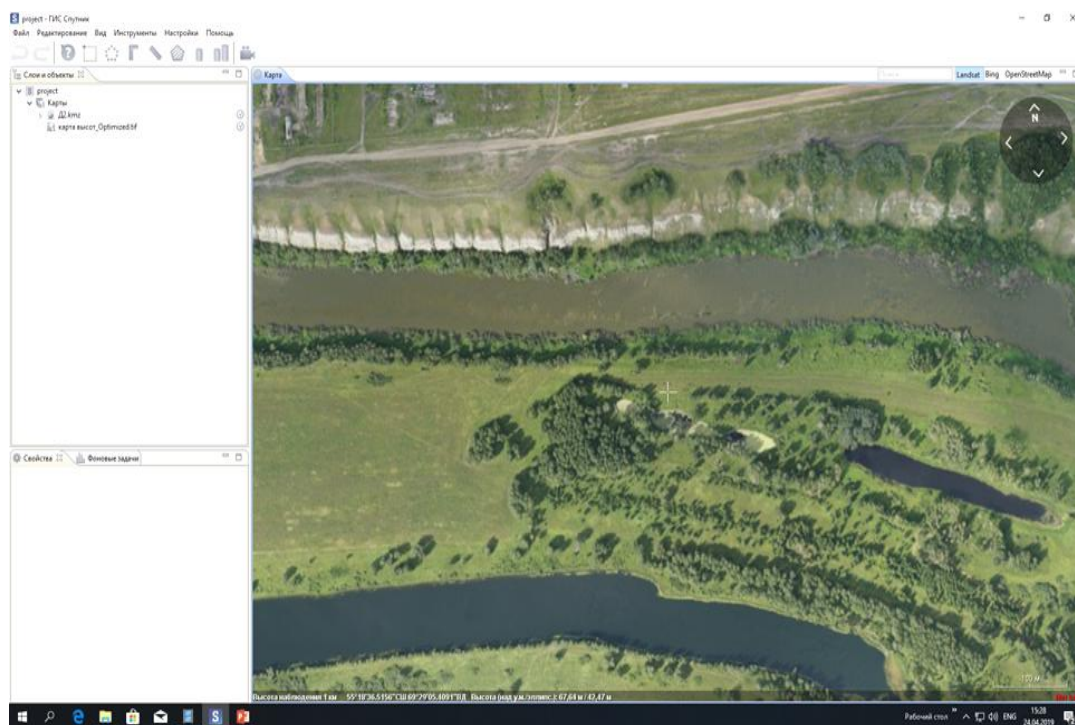
The next stage uses the GIS Sputnik program, which is an effective tool for visualizing and analyzing heterogeneous spatial data. The system supports work with vector and raster maps, three – dimensional models, point clouds, aerial photography data [5].

Below in the figure you can see that in the program you can make an approximation over the entire surface of the terrain (Picture 3).

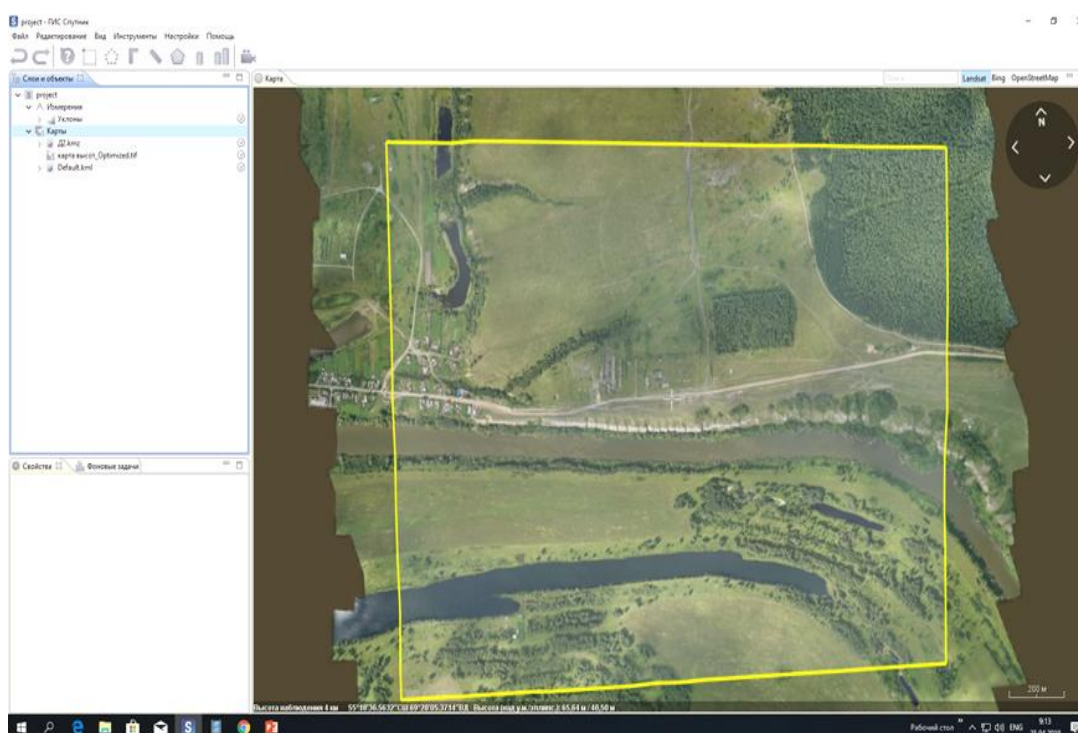
Using this program in this area, you can select a landfill by the level of flooding, that is, select the area of interest in this map for further detailed analysis (Picture 4).



Picture 2 View of the terrain in the GIS Sputnik program

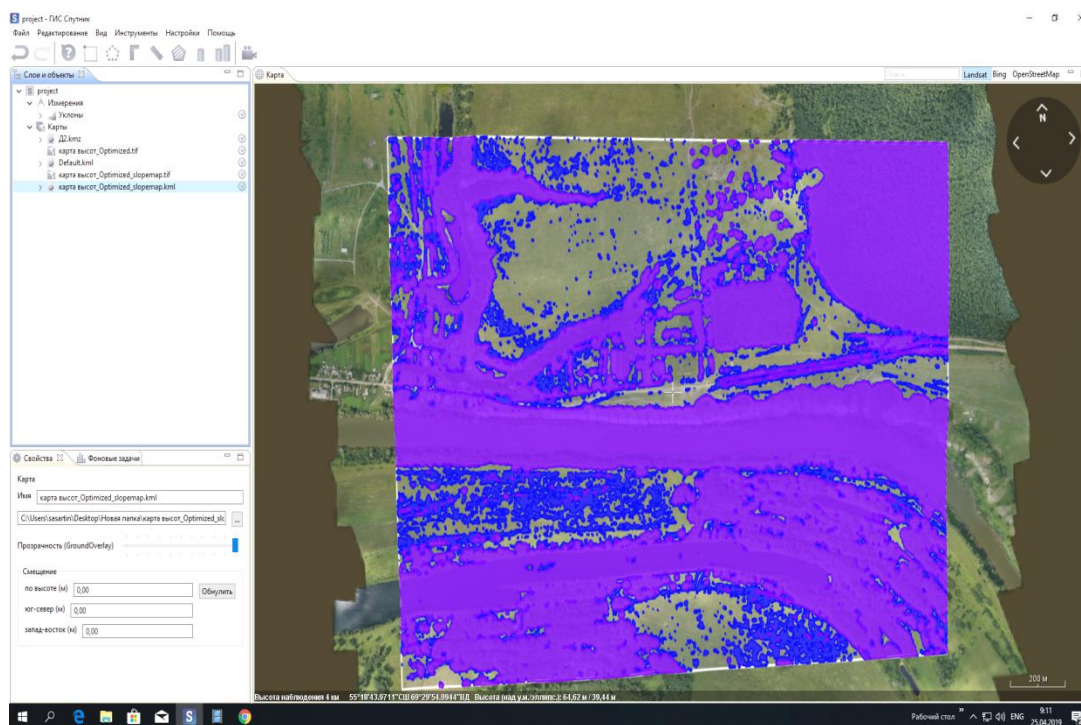


Picture 3 Terrain scaling capabilities



Picture 4 Polygon study area

The program features allow you to show flooding zones using different colors, setting the height characteristic for each color (Picture 5).



Picture 5 Estimated areas of flooding when the water level rises

### Conclusion

By varying the height of the selected landfill and subtracting the initial water level in the Esil River, it is possible to estimate the flood area. Visualization of a possible spill allows you to analyze the most unfavorable forecasts, exposing high rates of flooding. Thus, this method allows you to pre – assess the risks of flooding and warn localities, emergency services, which would further reduce financial losses.

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