

**Space technology and international cooperation for
environmental monitoring of the Caspian coastal
zone**

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ANASA's activity

ACTIVITY OF AZERBAIJAN NATIONAL AEROSPACE AGENCY

Azerbaijan National Aerospace Agency (ANASA) was set up to coordinate and establish scientific and industrial base for conducting fundamental and applied investigations in space researches of the Earth and application of results in the national economy of the country.

ANASA's scientific and industrial activities are related with the development of theoretical principles and design/pilot works and production of the system for gathering, processing, distribution and application of remotely-sensed data in order to investigate natural resources, land usage, environmental monitoring and forecasting of disaster events.

STRUCTURE OF ANASA

ANASA comprises of five scientific and technological enterprises, commonly including 900 employees:

- The Institute for Space Research of Natural Resources;:
- Institute for Space Informatics;
- Institute of Ecology
- Special Design Office:
- Pilot plant

Main directions

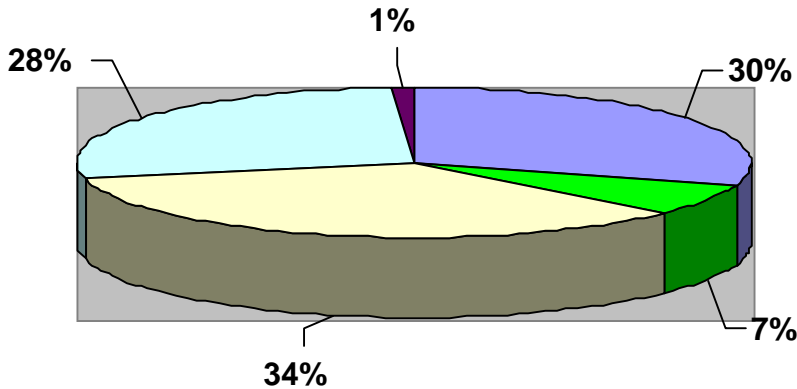
From the foundation ANASA acquired huge scientific potential in theoretical and practical fields of remote sensing. ANASA has a higher qualified personal with the practice of education in the developed countries.

Today ANASA continues to acquire experiences of works in the following main directions.

- **Scientific-methodic bases of determination the parameters of natural and anthropogenic objects using radiation characteristics of ones;**
- **Designing of complex monitoring system of the Azerbaijan environment on the base of aerospace science and technologies;**
- **Development processing of aerospace information and GIS technologies.**
- **Technical equipment for remote sensing and information measuring complexes. characteristic processes of degradation of coastal lands.**

Characteristic processes of coastal zone's degradation.

Reason of desertification in world



Pollution by oil lake (Apsheron)



The stone quarry (Apsheron)

The difference coastal zone of Azerbaijan

- Azerbaijan is a country which is located on the western Caspian coastal zone with population approximately 8 million people and has a territory 87000 square kilometers.
- The main feature of geographical position of Azerbaijan is that we are one of the five countries which are situated on the Caspian Sea and that is why all problems connected with environment of those countries are also characteristic for us.
- The difference of Azerbaijan from other countries is that all the industry of Azerbaijan and great part of its population are concentrated on the coastal zone.
- Caspian coastal zone is exposed to more different natural and technogen impacts. The complex landscape's relief amplifies influence of all factors on the environment.

The context of remote sensing development

- Global environmental processes
 - Global impacts;
 - Exploitation and management of the environmental
- Development of computer technologies
- Interdisciplinary approaches

- Regional projects in Azerbaijan

Since July 1999 till June 2001 in Azerbaijan was executed the FAO project

“Strengthening Capacity in inventory of Land Cover / Land Use by Remote Sensing”

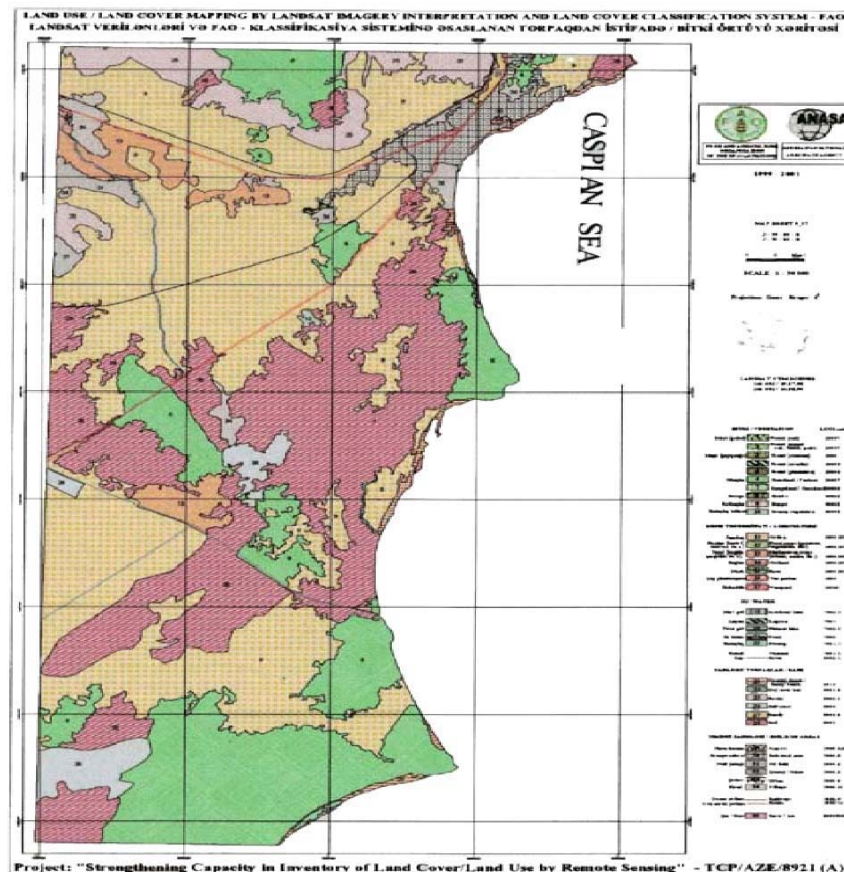
(ANAKA, Ministry of Agriculture)

- Since July 1999 till June 2001 TACIS project – ‘Combating desertification’ (Geography Institute of Academy of sciences)

FAO project “Strengthening Capacity in inventory of Land Cover / Land Use by Remote Sensing”

THE MAIN RESULTS OF THE PROJECT ARE:

- 1. For the first time for all republic the thematic maps of Land Cover / Land Use to scale 1:50.000 were obtained.
- 2. For the first time the digital model of Land Cover / Land Use for all republic was formed.
- 3. The unique database on Land Cover / Land Use of republic was formed.
- 4. The obtained thematic maps of Land Cover / Land Use to scale 1:50.000 were made according to the GIS- technology, generally accepted in Europe.
- 5. The obtained thematic maps of Land Cover / Land Use to scale 1:50.000 were bound to a system of qualifiers, designed in FAO (LCCS).
- 6. The database, stored in a computer memory, allows the item of information on any administrative region of republic to be given on printing operatively.
- 7. The formed digital model of Land Cover / Land Use can be utilized for the control of dynamic changes of a vegetative cover.



Sheet of the map
Land Cover / Land Use

TACIS project –'Combating desertification' (Geography Institute of Academy of sciences)

CRITERIA and MAPPING PROCESSES of DESERTIFICATION.

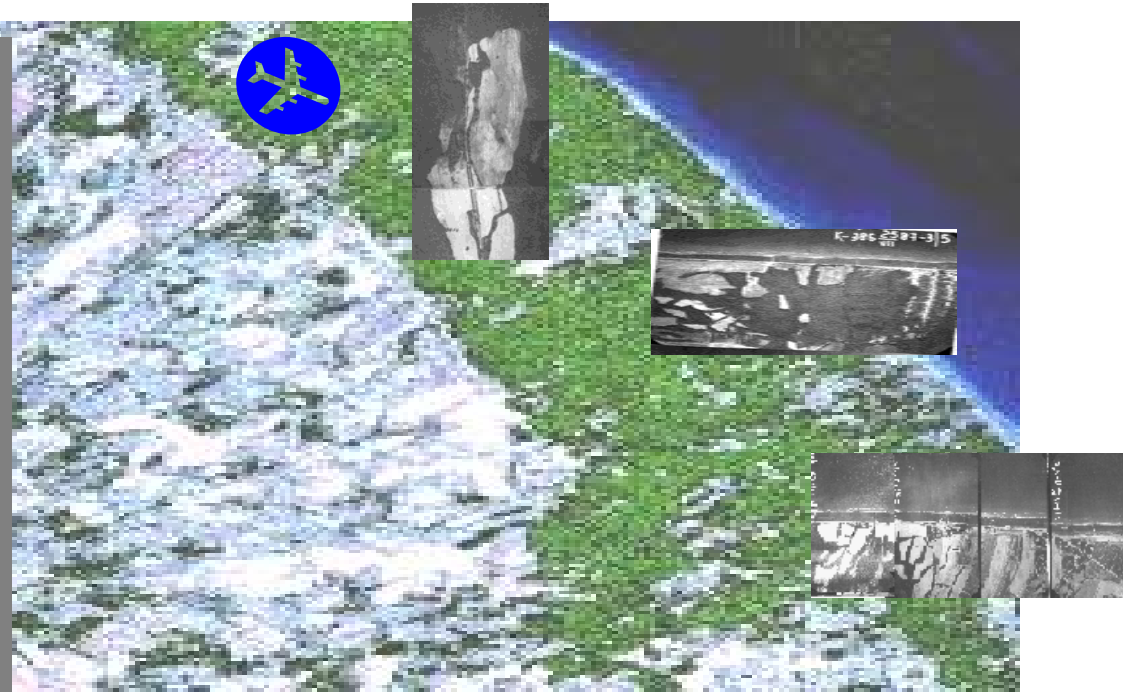
The methodological approach

- Basis of diagnostics and monitoring is indicators and the criteria, allowing to estimate the quantitative and qualitative parties of this process.
- From here the following circle of decided problems:
- Definition and estimation of desertification
- Definition of indicators of desertification - physical, biological, social types ecological systems, subject to processes of desertification;
- Development of criteria;
- Drawing up of maps of an estimation of desertification for the recommendation of measures in avoidance of possible negative processes;
- Development of precautionary measures on struggle against desertification:
- Development and the organization of a technique and the organization of monitoring of researched territory;
- Development of recommendations for struggle against desertification.

Airborne subsatellite monitoring of land and forested ecosystems' degradation in Caspian coastal zone of Northern Azerbaijan

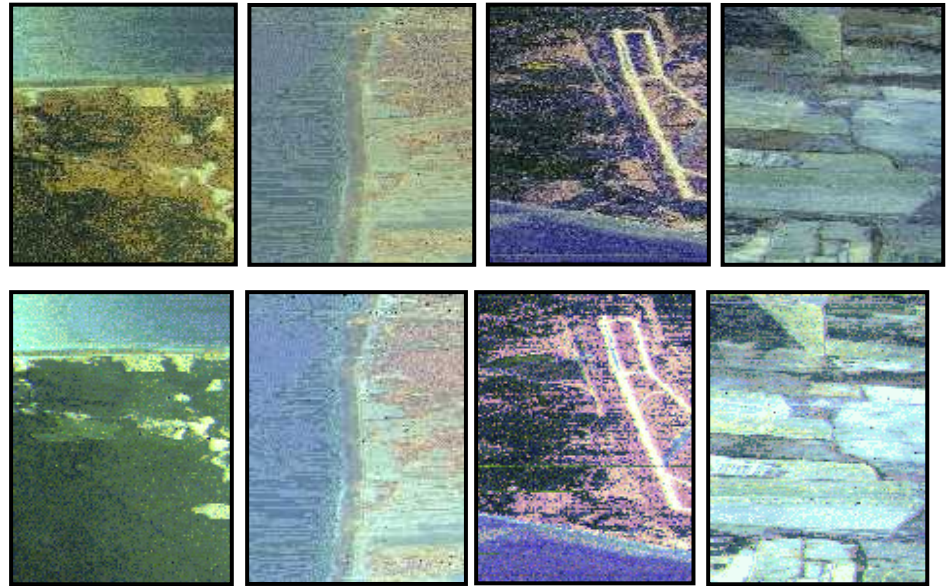
The degradation zones of forested and coastal territories in Northern AZERBAIJAN are separated on multi-spectral aircraft scanner imagery to demonstrate the typical variability of spectral and optical contrast characteristics in different scale for anthropogenic and natural processes of deforestation and desertification.

We can see here 3 sites of characteristic degradation effects: deforestation (cut down), coastal erosion, soil cultivation and urbanization results



Deriving Image patterns of Caspian coastal degradation in Northern Azerbaijan using nonlinear correction

Upper multi-spectral images received by surveying in 8 channel of aircraft scanner "Absheron". Series of characteristic degradation zone, is derived by standard atmospheric and radiance correction. Second series derived by the nonlinear correction allows to extract reference contrasts of degrading sites. Transformation of multi-spectral images into small RGB-format being more natural for perception often makes analysis easier for plant-soil and water ecosystems' state to be estimated effectively using remotely sensed data . Thus the soul interest introduces informative increases at change aircrafts survey parameters : the spatial and spectral resolution, number of brightness gradations



Planning the aircraft multi-spectral scanning

Planning the aircraft scanning we have to account of any restrictions on each kind of aerospace information derived from both – airborne and satellite data. On generalized satellite image we can overview the distribution of degradation zones and common spatial variance of its characteristics.

It's well known that airborne scanner imagery gives more in detail the spectral information of objects. And in spite of its local specification we can derive enough information of object's state since spectral characteristics are sensitive to its change.

Researching the object's state on airborne multi-spectral imagery we can spread derived results to wide territory using calculated coordinate distribution planned for scanner control beforehand.

Multispectral scanner “Absheron”

The parameters of the multi- spectral scanner are demonstrated. Now we need the thermal IR channel to be added for increasing the class of solved problems, including detection the emergency dangerous situation on ecologically tight sites and condition state of the oil pipeline at video-certification

Basic specifications of system "Absheron"

Optical mechanical scanner

Spectral range of optical system - 0,4-2,5 micrometer.

Work spectral range of optical mechanical scanner (pass band)- 0,4-1,1 micrometer.

Number of measurement channels-8.

Channel's Number	Spectral ranges (nm)	Width band (nm)	Remarks
1	500	10	
2	525	10	
3	547	10	
4	850	80	
5	1000	100	
6	474	10	
7	452	10	
8	400-850	450	

Total field of view - 28,6 degrees.

Ground resolution element - 10-20 meters, height - 5000 meters, speed of flight - 360 m/sec.

Instantaneous field of view - 1,3-2,6 mRad.

Frequency of scanner- 8 line in second.(constant)

Number of active elements in scanning string - 384.

Type of filter-interference.

Power requirement 250W.

Preprocessing-on the aircraft.

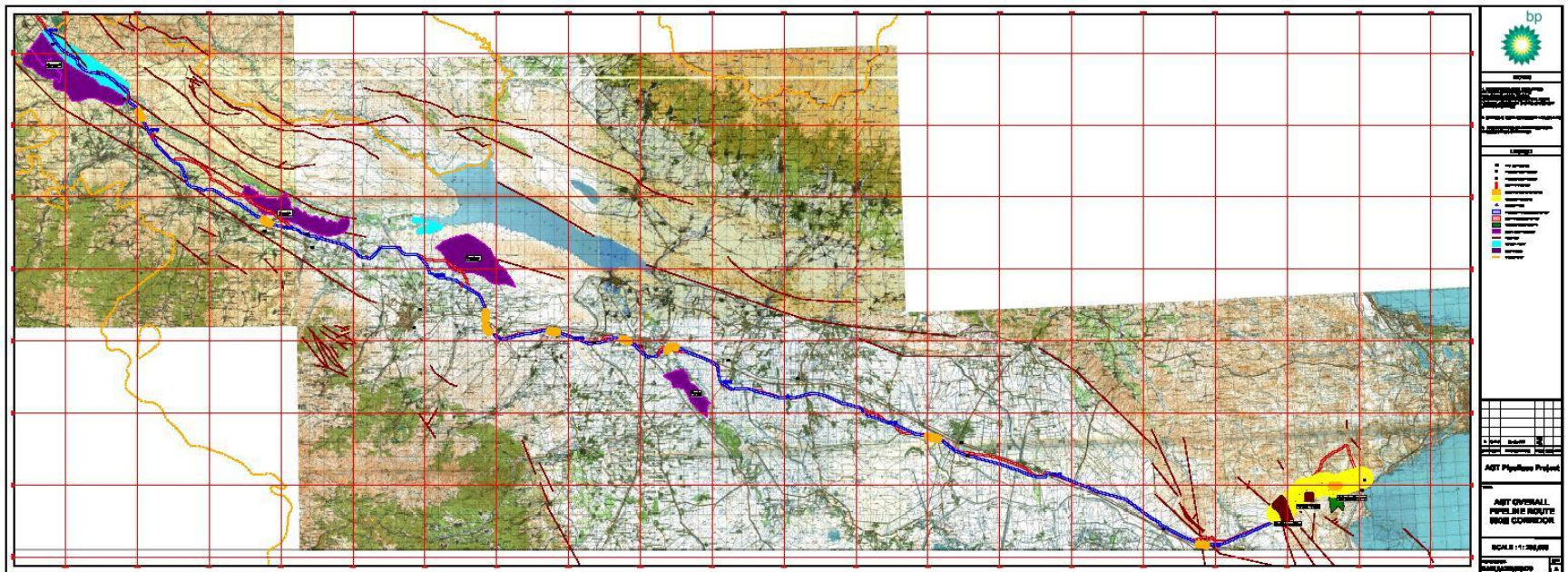
Dimensions-250 (W),400(D),450(H)mm without knobs and connectors.

Voltage (direct current)- $+27 \pm 4$ V.

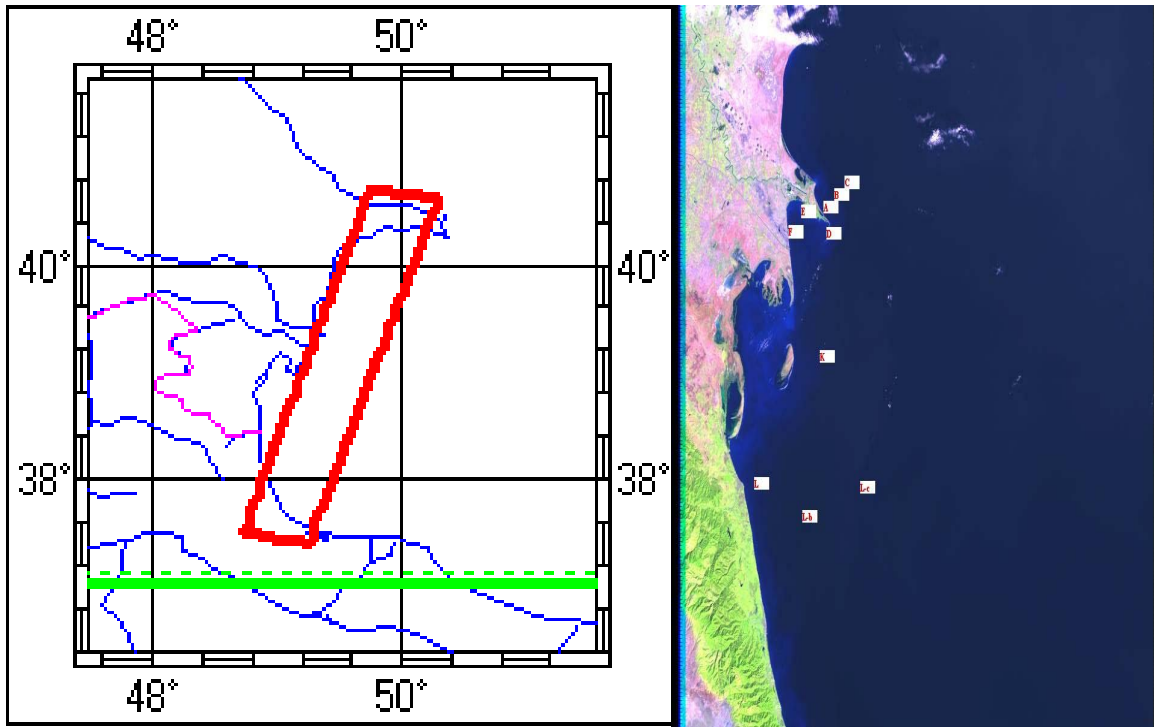
Wight-Approximately 13 kg.

Baku-Jeihan pipeline

The video-certification of oil-pipeline is designing using environmental monitoring and aerospace multi-spectral data. We intend using all peculiarity of aircraft survey by 8 channel “Absheron” scanner.



Chosen oil-explored region of South Caspian nearshore zone



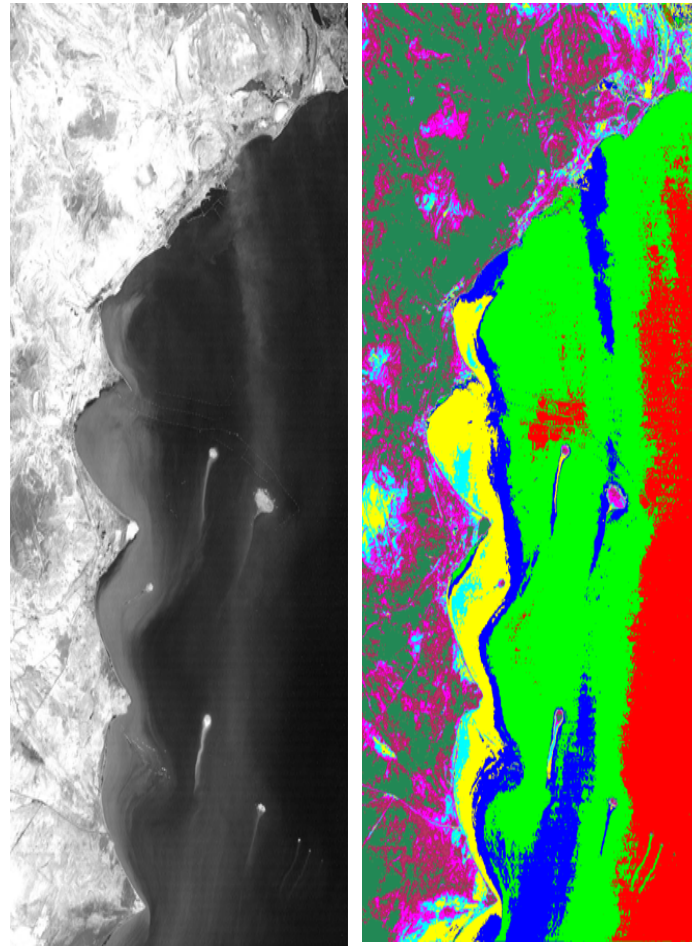
The intensive oil explored region by EXXON-Mobil (Projects :Zafar-Marshal, Nakhichevan) and other Oil Companies.

It's dangerous for environment of Caspian coastal ecosystems and needs international ecological investigation of such activities' consequences

ENVI image processing for coastal zone toward north of Bendovan cape

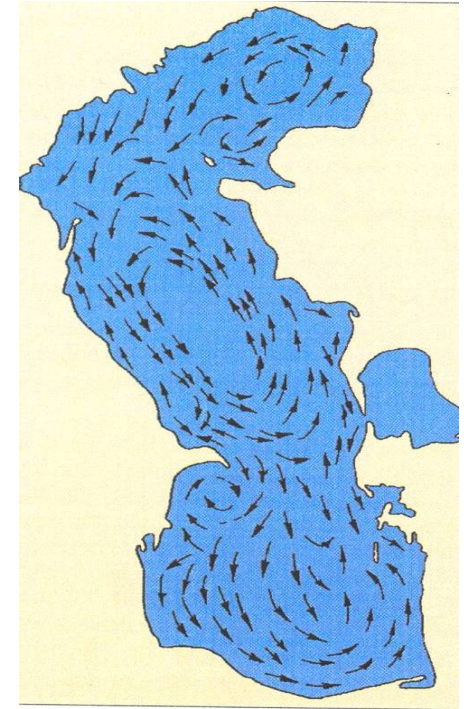
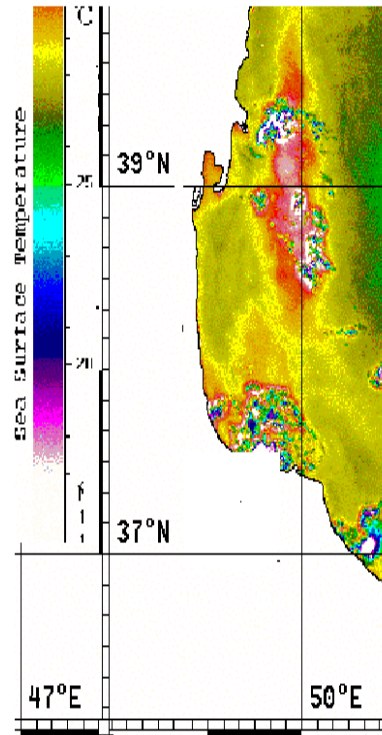
We can see changes of suspended sediments' (green color) and oil hydrocarbon area (dark blue color) along nearshore water.

Toward south near Cape Bandovan (close to new oil exploration territory) the oil hydrocarbon area increases.



Caspian temperature distribution and Hydrological circulation regime

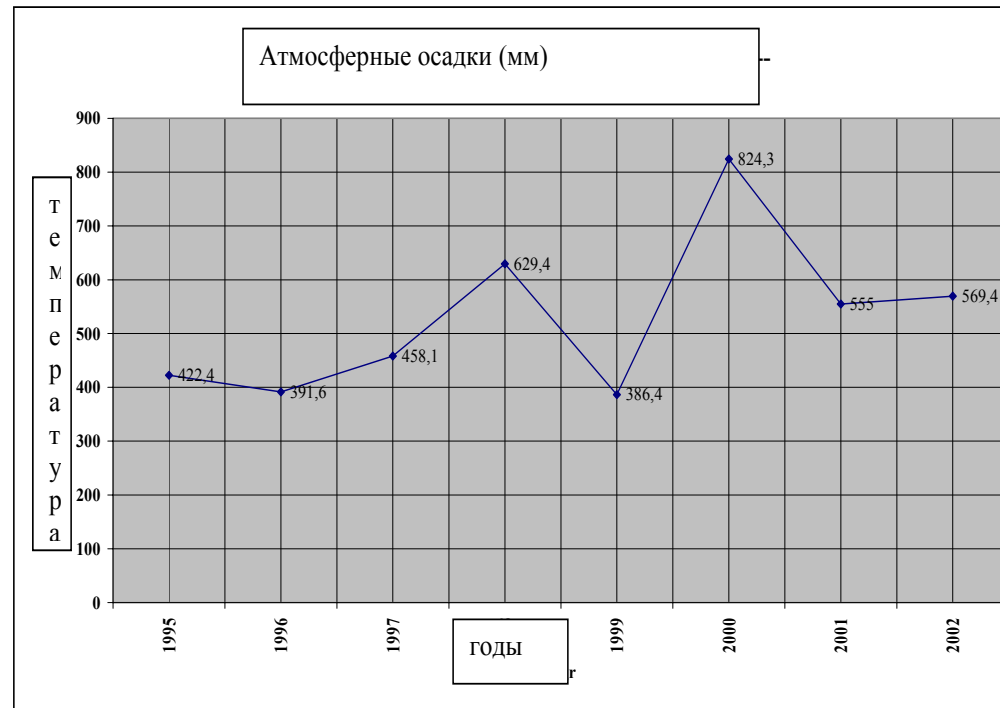
Temperature gradients' distribution and hydrological circulation regime influence on oil pollution spreading alongside with all South coastal zone. Now we can watch increase of oily impurities' and hydrocarbon components' concentration close to the **Lenkoran-Astara** zone.



Jalilabad

ДЖАЛИЛА БАД

The strengthening of trans-boundary effects is promoted also by drift of meteorological parameters (temperature, humidity, of precipitations) that is watched in this zone for last decades. The climate changes to more droughty as a result of a deforestation, that can hereinafter result in a desertification and global change of a climate. It can also have an effect on increase of frequency mudslides and landslides as result of mountain decline's erosion

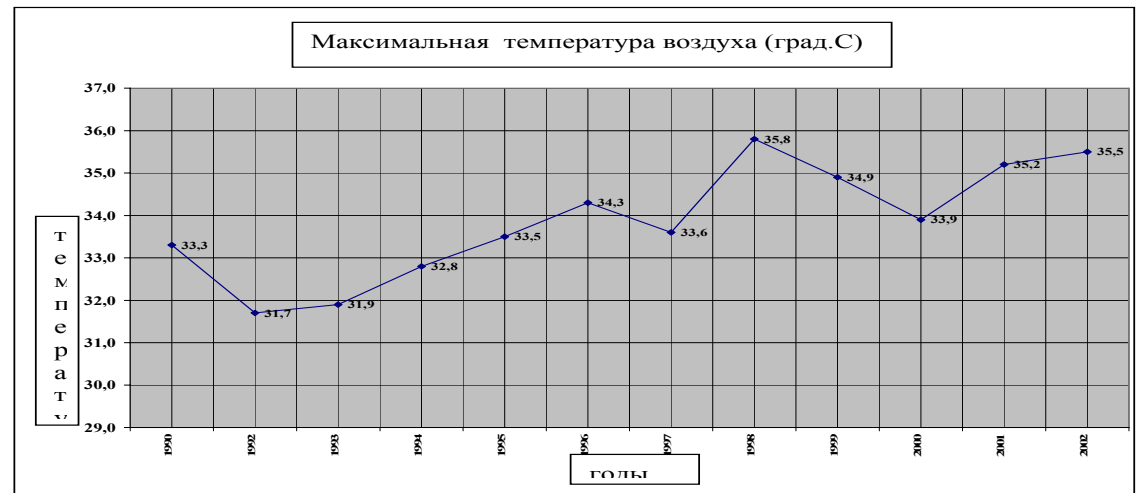
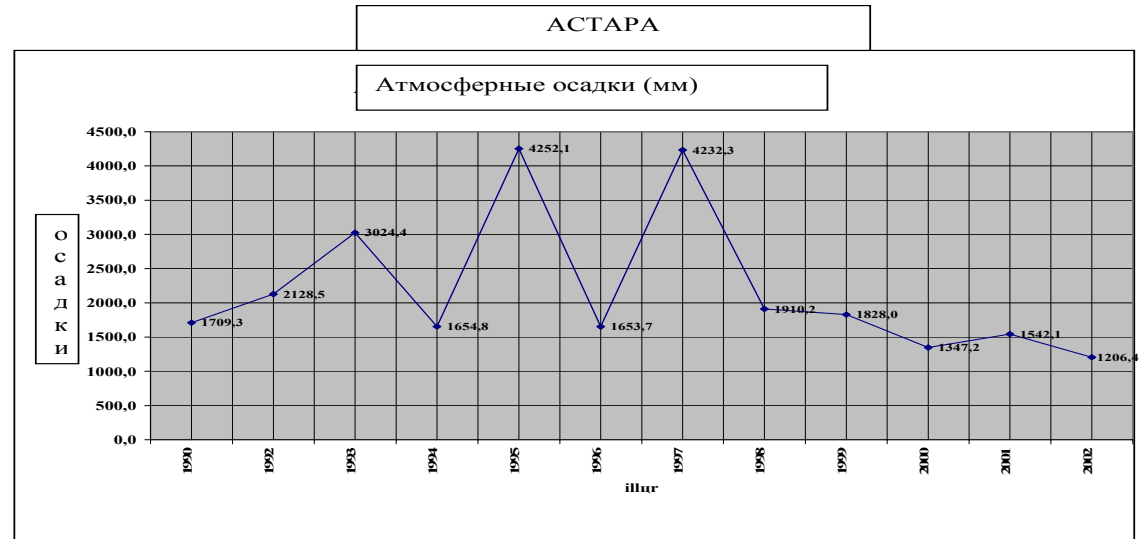


ASTARA

On the upper picture we can see the atmospheric precipitation's decreasing for last decades in Astara restrict.

On second graphic we see the air temperature is increasing for last decades.

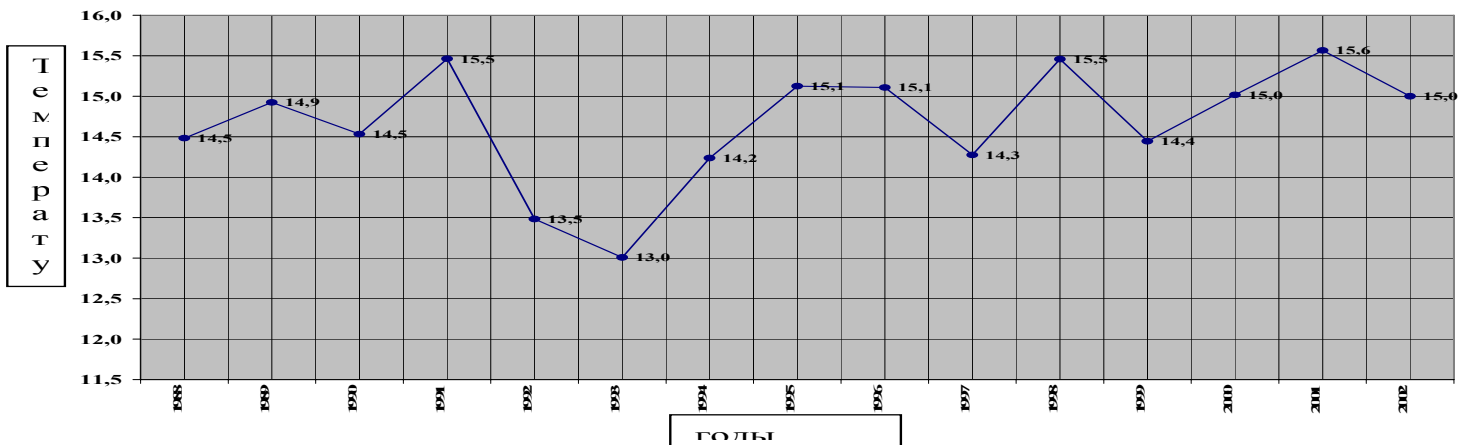
The meteo-parameters drift toward more draught climate here



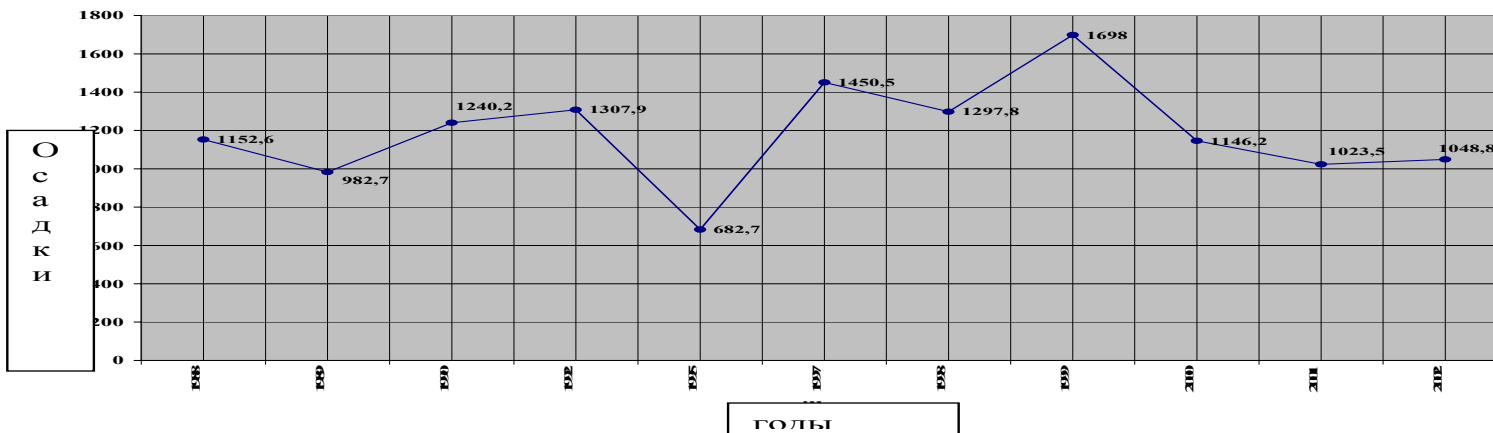
LENKORAN

ЛЕНКОРАНСКАЯ ЗОНА

Средняя температура воздуха (град.С)



Атмосферные осадки (мм)



For this purpose the multi-layer submission of specific fields of contrasts, reference reach type and stage of a predictable ecological process is offered. Apparently these types presented in layers should be differed not only in reference spatial-temporary variability, but also in intensity instituted by proximity to a stagnation point, being in appropriate way mirrored in reference fields of contrasts. Now we spend activities on simulation of spectral - optical and radiation indicators of instabilities of dynamic ecosystems and influencing of affinity them to critical states. And the main attention among advanced researches is given to extremely dynamic natural processes: to landslides, mudslides, high waters and floods.

In result we have the simulated ranges of coordinate distribution with maximum informative content evaluated.

Thus we need at least that initial information from preprocessed satellite imagery to be used for planning the aircraft scanner measurement in defined coordinate distribution. In turn those include optimum information of process development for predicted directions.

We can see aircraft scanner images surveyed in derived coordinates with maximum information supposed.

The further improving of the similar modeling is connected to an outlook of more broad usage of some perfected models & algorithms for the recognized process to be simulated numerically. It's necessary for all main factors influencing on violations of ecosystems stability to be counted & determined to define the gear of optical and spectral contrasts deformation as a result of radiation balance violation. Meanwhile, the accuracy of anticipated outcomes at these stages can succumb to latitude of models scope attracted for all initial capabilities to be reviewed.

GNNS open many directions for application. But development of its application depends in base of programs designing for interface with GPS user.

And such kind of applied programs for interface with plenty application directions is supposed to be main guarantee for providing any further benefit of GPS perspective use.

Perspecive projects

In conclusion I would like tell about our perspectives projects:

- **Development GPS –GLONASS systems of production introduction in economy of Azerbaijan.**
- **Development of aircraft multi-spectral scanning means and designing program for planning survey tracks with GPS – positioning more informative coordinates of researched ecosystems and anthropogenic processes.**
- **Designing the RS system for monitoring and video-certification of pipeline including environmentally dangerous sites subjected by landslides and other disasters.**
- **Development of environmental monitoring system of oil exploration territory, including tracing oil slicks, those spreading. Environmental monitoring of trance-boundary processes of anthropogenic processes including oil pollution, climate change and other.**