CARTOGRAPHIC MONITORING OF A SOIL EROSION OF THE MOUNTAIN TERRITORY OF TAJIKISTAN

H.M. Akhmadov

Tajik Academy of Agriculture Sciences, Dushanbe 734025, Rudaki str. 44a - ahmadov@yandex.ru

KEY WORDS:. Satellite Image, Land Degradation, Photo Tone, Textures, Structure, Mapping

ABSTRACT:

Study and analysis of available satellite images (SI) and comparison those with traditional soil-erosive cartographic materials have shown that the satellite images have high information capability. The application of SI at study of mapping of soil degradation and comparison of results of decipherment with the traditional erosive materials which have been carried out in different terms, enables objectively to develop a way of display erosion and deflation with division them on gradation wash-off and deflation on a soil-erosion map and various category of degradation and on their basis to give the forecast development of land degradation and vegetation. SI is a good material for drawing up a map of density, length and area of the gully erosion. For revealing regularity of distribution of the soil degradation, on the basis of existing SI made a map of soil erosion, soil, salinization, gully erosion of mountain territory of Tajikistan. At drawing up a map of soil erosion above examined region, we took into account first of all basic reflective abilities of soil vegetation cover according to their deciphered attributes (indirect and straight) on the different scales satellite images. Besides the use of occurring at different times SI give to us the basis to use them for monitoring a soil cover. The cartographic monitoring of Tajikistan gives us an opportunity to predict the further condition of soil cover, which is necessary for planning steady development of the mountain country.

1. INTRODUCTION

Cartographic monitoring of land and vegetation degradation in the territory of Tajikistan till now has not been carried out, but only the schematic (survey) maps of soil erosion, salinization, vegetation and agricultural lands of miner scales. Some part of these cartographic materials, including erosion, owing to prescription of performance of soils shooting works and change of objects under the influence of human activity, has become outdated and does not address many urgent issues having basic importance at designing and the decision of social and economic tasks on melioration of eroded, deflated, erosion-dangerous and deflation-dangerous lands and involving them in agricultural turnover. Last years for drawing up of a soil-erosive map and the maps of vegetation and anthropogenous influence on soil - vegetative cover with the purpose of use them for monitoring of these eco-systems space and satellite images are used. The space information, due to the large visibility, one time scope of significant territory, represents a valuable cartographic material for study of dynamics (changes) of many natural objects and processes, including erosive phenomena and soil-vegetative cover. Therefore, decipherment of processes of degradation of soil and vegetation and the features of their development on space photo screen with the purpose of creation of a thematic map the has a large theoretical and practical meaning.

Study and analysis of available space photos and aero space photos and comparison those with traditional soil-erosive and vegetative cartographic materials have shown that the satellite images have high information capability. On them soil-erosive and vegetative objects (the contours) are distinguished depending on change of phototone, textures, structure, figure, form, size of the image and their combinations about presence of close correlation connection with reflective ability of a soil and vegetative cover.

The application of space photo snapshots at study of mapping of eroded soil and degradation of vegetation and comparison of results of decipherment with the traditional erosive and vegetative materials which have been carried out in different terms, enables objectively to develop a way of display water, irrigation, gully erosion and deflation with division them on gradation wash-off and deflation on a soil-erosive map and various category of degradation of vegetation of Tajikistan and on their basis to give the forecast development of degradation of land and vegetation. Besides satellite images and aero space photos is a good material for drawing up a map of density and ravine areas

2. MATERIAL AND METHODS

For revealing regularity of distribution of degradation of soil and vegetation, we, on the basis of existing space photos from the artificial earth satellite of scale 500 000 - 1 000 000 (original and increased) and experimental satellites "Meteor" having television devices on their board, made a map of soil erosion of Tajikistan. The space photos from the experimental satellites "Meteor" and spaceship “Soyuz” were carried out from the height of 300-650 km in four zones of a spectrum of the small sanction (0,5-0.6; 0,6-0,7; 0,7-0,8; 0,8-1,1; mmk) and two medium resolution (0,5- 0,7 and 0,7-1,1 mmk). For specification and the comparison the aero photos were also used. Besides all allocated contours were checked up in a nature by routing inspection and with the description of soil-erosive and vegetative cuts.

At drawing up a map of soil erosion and degradation of vegetation above examined region, we took into account first of all basic reflective abilities of eroded soil and vegetative cover according to their deciphered attributes (indirect and straight) on the different space information. Therefore at erosive decipherment of soil and vegetation, in our opinion, is inexpedient to be guided only by any one attribute of display (direct or indirect) of them on space photos.

For more exact decipherment of space photos in various parts of mountain territory of Tajikistan we chose reference sites and on their basis the catalogues of the standards of the basic types and sub-types of erosive processes were developed. At drawing them up, alongside with other attributes and properties of space photo, mainly, figure space photo reflection was taken into account which represents set of structure, texture and phototone. For performance of these works the various complete sets were analyzed, kinds of space photos (black-and-white) and decipherment on characteristic sites was carried out. Besides in our opinion soil degradation is always accompanied with degradation of vegetation. Therefore at division of soil degradation we mean degradation of all mountain ecosystems (Akhmadov and Mazko 1996).

As a reference site of irrigated territory with development of all kinds of irrigation erosion Yavan valley located in a southwest part of Tajikistan was chosen. Phototone of a complex irrigated typical grey soil subject to a weak and medium degree of irrigation erosion, basically dark grey, with small grey spots. The structure is non-uniform and wide stripe. Texture is rectilinear - guided. Phototone of a complex irrigated typical grey soil subject to a medium and strong degree of irrigation erosion from grey up to light grey. The structure is wide stripe. Texture is rectilinearly focused. Along the river Yavansu and other large negative forms of a relief gully erosion intensively develops.

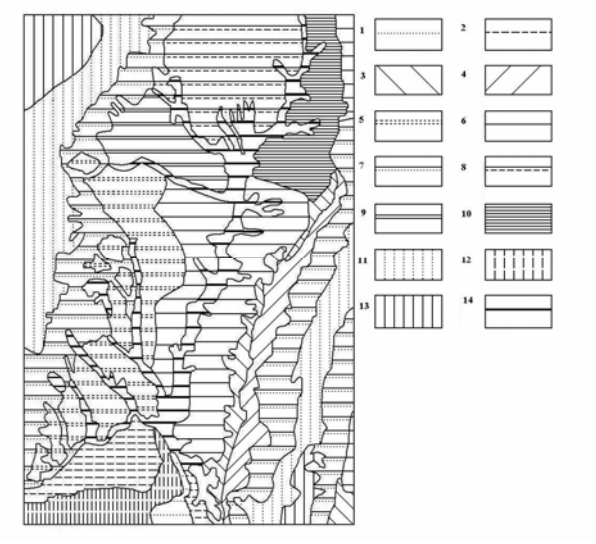

Figure. 1. Fragments of a map of soil erosion of the mountain territory of Tajikistan (grey soil of Yavan valley subject to an medium and strong degree of irrigation erosion).

Conditional designations: 1- weakly eroded light grey soil; 2- light weakly eroded weakly irrigated grey soil; 3- Typical grey soil medium eroded; 4- typical grey soil the erosion, subject on the medium degree; 5- complexes of irrigated grey soil, subject to weak and medium irrigation erosion; 6- complexes of typical irrigated grey soil, subject to strong irrigation of erosion; 7- dark grey soil, strongly eroded; 8- irrigated dark grey soil, subject to weak irrigation erosion; 9- irrigated dark grey soil, subject to medium irrigation erosion; 10- complexes of irrigated dark grey soil, subject to medium and strong irrigation erosion; 11- brown carbonate soil strongly eroded; 12- irrigated grey meadow soil, weakly eroded; 13- complexes of brown carbonate and brown carbonate cultivated soil, strongly eroded; 14- territories broken down by gully and strong washed off soil.

Gullies are represented on space photos by narrow, precisely outlined notched form. Because of destruction of a soil cover, wash-off of humus and supply of soil created rocks they are represented by bright - light tone. On space photos it is possible to distinguish all stages of gully creation on change of the forms and sizes of the image. Besides in Yavan valley the negative forms of a relief are precisely allocated, which have extended, a little bit twisting treelike form. Bottom and the slopes of the negative form of a relief arecovered with grassy vegetation, and sometimes wood. On space photos of a contour of the top part of the negative forms of a relief are represented by homogeneous grey tone and middle and bottom parts by dark grey tone, which is caused by development of richer vegetation. On the basis of the above mentioned of space photos the map of soils erosion of Yavan valley is made, where all kinds of soil erosion are allocated (Fig. 1).

3. RESULTS AND DISCUSSION

On the basis of all these criteria the map of soil erosion of Tajikistan is made. For example, on space photo, in of Southern Tajikistan deflation is well deciphered, having here wide circulation. On a map «Erosion and soil melioration " made by a traditional method by M.R. Yakutilov and I.K. Jabbarov (1968), this territory is shown by a conditional designation only to medium and strong erosion (Fig. 2). However for this territory allocate some types of erosive processes with characteristic contours subject to a various degree of erosion on this space photo (Fig.3). As a result of use of the literary data and analysis of the various photo images on space photos we allocate thirteen types of irrigated lands of a various category of erosion and breaking down and three types of irrigated territories on prescription of their development: old-irrigated territory with weakly marked erosion and with individual gullies; irrigated land with the precisely marked erosion and with numerous gullies.

On slopes of mountain ranges Babatag, Aktau, Karatau etc. we allocated different soils (grey, mountain brown etc.), attributed to proluville adjournment, where weak -, medium- and strongly eroded water erosion sites are precisely fixed on tone, figure and structure of the image on the space photos.

On space photos by virtue of their high date bearing on southern and south - western parts of area multy-coloured lowlands of Southern Tajikistan a huge territory of strongly divided by the negative forms of a relief (beams, narrows, hollows and hollow-like downturn) are depicted. In geomorphology such lands can be referred to "badlands".

On space photos these negative elements of a landscape have extended, twisting, treelike, sometimes linear forms of the image. On space photos such territories have white - grey colour. But when the slopes of negative elements of a relief are strongly over-covered with turf, on space photos they have grayish - dark tone. Here it is necessary to note, that on space photos to each type and sub-type of land the certain tone of the image corresponds. At the same time the occurrence on their backland of other structures and figures specifies presence of various degrees of eroded soil formations inside these contours. Weakly washed off soils within the limits of southern and south - east parts of area multy-coloured lowlands of Southern Tajikistan are attributed basically to valleys and low mountain zone. On space photos in a zone of rainfed agriculture they have darkly - grey tone, and in irrigated zone - blackish colour caused by excessive humidifying grey - meadow soil. Medium eroded soil

distributed in a belt of brown soil (within the limits of mountain ranges of Vakhsh, Sarsak, Teriklitau, Jilintau, Khazratishoh etc.) are characterized by presence grey and darkly - grey tones. Sometimes among these apportionments numerous flood gullies are clearly represented, as very fine white narrow bands. On examined territories the natural gully erosion with characteristic fine white lines of the photo is widely developed. On space photos strongly eroded soil advanced in a zone mountain brown soil are very clearly allocated. This apportionment of soil on space photos has grayish - grey tone of the age with white strips and spots.

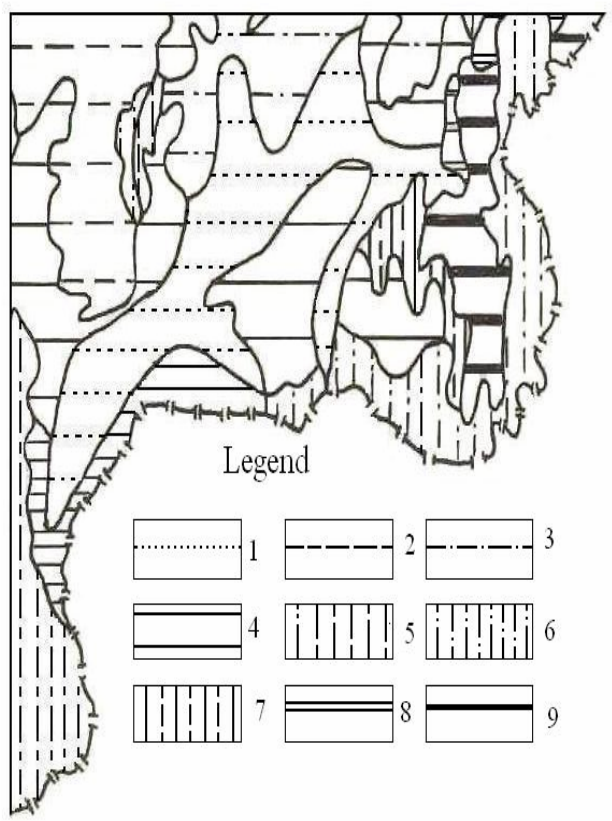

Figure. 2. Fragment of a map of soil erosion of Tajikistan (Yakhsu and Kizilsu watershed), made on the traditional method by M.R. Yakutilov and I.K. Jabbarov (1968), scale 1:500.000

Conditional designations to legend of the soil erosion map of Southern Tajikistan made traditional method:

1-irrigated lands subjected to partly wind and irrigation erosion; 2-half-provided with precipitation rainfed area subjected to temperate water erosion; 3- provided with precipitation rainfed area subjected to medium and strong water erosion; 4- foothills southern valleys subjected to wind and water erosion; 5-mountain desert subjected to water and wind erosion; 6- foothills and low mountain area with xerophytes forest subjected to water and wind erosion; 7-middle and high mountain zones subjected to negligible erosion; 8-middle and high mountain zones subjected to medium and strong erosion; 9- rack face.

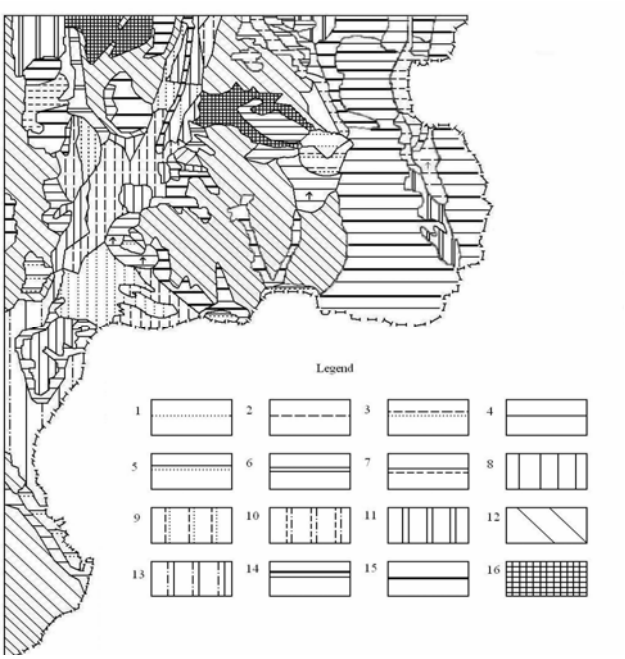

Figure. 3. Fragment of a map of soil erosion of Tajikistan (Yakhsu and Kizilsu watershed), made on the basis of space photo, scale 1:500.000, film 2033, frame 0589.

Conditional designations to legend of the soil erosion map of Southern Tajikistan made on a basis of space photos:

1 - weakly washed off; 2 - medium washed off; 3 - strongly washed off; 4 - very much strongly washed off; 5 - deposited; 6- medium deflated; 7 - strongly deflated; 8- irrigated lands subjected to strong erosion with density more 5 un./km2; 9- irrigated lands subjected to weak water erosion and medium deflation; 10- irrigated lands subjected to weak water erosion and strong deflation; 11- territories strongly subjected to ravines with fragments of medium and strong wash off of land; 12- "bad" lands; 13- semi-alloted sand; 14- the strongly broken down territory with fragments of a medium and strong degree of water erosion and medium deflation; 15 - irrigated land medium subjected to water erosion and deflation; 16- territories strongly broken down by the negative forms of a relief with fragments of medium and strong wash off of land and outputs of radical rocks.

Above zone of mountain brown soil the high-mountainous meadow - steppe and high-mountainous steppe soil subjected in a different degree to erosive processes are distributed. The sites of strongly eroded soil here in the most part are attributed to strongly divided territories of mountains, where gully erosion both on friable, and on dense radical rocks are very widely spread. The outputs of conglomerates and red-coloured sandstone on space photos are represented by black and dark phototone that on the first sight creates impression with non-erosion soil. But at complex acceptance of deciphered attributes it is easily possible to find out, that outputs of radical rocks here are observed. Therefore strongly eroded sites of highlands on space photos are confidently decoded on light - grey tones from white insignificant width by strips and small dark spots.

On a map of soil erosion, the territory of Darvaz conglomerates, Alai - Zerafshan - Hissar of the mountain country and Hissar valley concern to different categories eroded.

From the point of view of decipherment the Fergana valley, Kuramin and Turkestan ranges are of great interest. On a map of soil erosion made by M.R. Yakutilov and I.K. Jabbarov (1968) northern slopes of Turkestan range is described as medium eroded. However, on space photos the wind erosion is precisely allocated around Kairakum reservoir, in a coastal zone of Syrdarya river, northern and northern - western parts of the Fergana valley. The foothill zone of above mentioned ranges, which are combined by aluville, deluville and proluville deposit, is cut strongly up by the negative erosive forms of a relief, with which on space photos the numerous different sizes of a strip of white colour correspond. The field supervisions have shown that the bright white colour on space photos is caused by the fact that these negative forms of a relief are filled with material carrying with a wind. Out of this fact it is possible to make a conclusion, that in foothill and low mountain zones of Kuramin, and Turkestan ranges the wind erosion prevails above water and is dominant.

In a high-mountainous zone of examined territory and on the Pamires high-mountainous deserted -steppe, deserted, takyro-like, meadow - permafrost, meadow - marsh soils and saline soil are developed.

These soils depending on genetic features and geographical areas of distribution on space photos are clearly allocated and contoured. On sites, where high-mountainous meadow permafrost and high-mountainous meadow - marsh soils are developed, the processes of wind erosion are poorly marked and consequently they are decoded doubtfully on the space data. Most sharply contours eroded soil here differs in a belt of high-mountainous deserted, high-mountainous zang and high-mountainous takyr-like soils. Eroded sites on the territory of these soils are represented in the most part of light - grey and grey phototone of the image. On coasts of high-mountainous lakes Karakul, Rankul, Shorkul, Kutakul deflation of soil with formation of aeolian forms of a relief is widely spread. This type of soil erosion on space photos is also clearly shown in east part of lakes Karakul and Rankul with characteristic of light - grey colour and ridge - spotty lines as narrow white and darkly - grey tone images.

Mountain territory of Tajikistan is known to be characterized by complexity and variety of natural and economic conditions. Notwithstanding, the analysis of the space information shows, that development of different types and sub-types of soil and the erosive processes, accompanying them, are attributed to certain soil - geomorphologic landscapes and files of newly irrigated, irrigated and old-irrigated regions.

4. CONCLUSIONS

Analysis and the comparison of space photo images with traditional soil - erosive materials shows, that with the large accuracy and reliability on snapshots water, wind, gully and irrigation types of soil erosion and different category of degradation of vegetation are distinguished. Among these soil - erosive types and degradation of vegetation on space photos are precisely allocated weakly, - medium and strongly eroded soils caused by various development on their surface of vegetative communities, and contents humus, moisture, salts, carbonates, depending on attribution of them to the certain conditions of macro - and micro - relief. These geographic - genetic properties and the ecological features of eroded mountain soils of Tajikistan are well reflected on various phototone of space photos, by texture and figure that has given us an opportunity to establish and contour on space photos various groups of eroded soils and on their basis to make a map of soil erosion.

The received results allow not only to specify areas of distribution of eroded soil of this region, but they are necessary for the correct account of dynamic soil resources with the purposes of their rational use and protection.

Besides the use of occurring at different times space photos give to us the basis to use them for monitoring a soil and vegetative cover. The cartographic monitoring of mountain territory of Tajikistan gives us an opportunity to predict the further condition of soil- vegetative cover, which is necessary for planning steady development of the mountain country.

REFERENCES:

Akhmadov Kh. M., Mazko V.M., 1996. Soil erosion process and combat to desertification. Dushanbe: pp.70-71

Yakutilov M.R., Jabbarov I.K., 1968. Tajik SSR Atlas. Moscow-Dushanbe: pp. 67-68