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Autor: Badenkov, Yuri P. / Merzliakova, Irina A.
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Natural Hazards in Mountains: Their Impact on the Regional Development Trends

Yuri P. Badenkov and Irina A. Merzliakova

Introduction

The problems of sustainable mountain development were a special emphasis of the UNCED (Rio, 1992) Resolutions (Mountain Agenda, Chapter 13). The concept of sustainable development is rather popular with scientists, and even more popular with policy-makers. However, its ideas are rather diluted and it is perceived as an ethical basis of the environment-economy-society interaction, rather than an integrated scientific theory of development.

The most crucial aspect of the problem is how to integrate the various processes and factors which control the status and processes in the complex system of regional man–environment interactions. What is the role and relationships of the factors internal and external to the system, which are deciding the overall system's development trends? What can be the method of quantitative description of the stable and dynamic relationships in the subsystems forming an integrity? These issues are far from being a novelty, but they became more urgent at the end of the 20th century, in view of the global significance acquired by the problems which were formerly limited to the local and regional levels.

The outstanding Russian pedologist V.V. DOKUCHAEV, who was studying chernozem soils as a product of the biotic-abiotic interaction in the Russian Plain, came to a fundamental theoretical conclusion in the end of the 19th century. He discovered that soil provides a record of the processes and conditions which formed it, as well as of the landscapes of which it was part. It was then that he formulated a well-known aphorism: "Soil is landscape's mirror".

Borrowing this citation from DOKUCHAEV, one can say that in the regional economic-environmental model suggested in 1978 under the Swiss MAB Project (MESSERLI, B. & MESSERLI, P., 1978) it is the landuse system which is a mirror reflecting the relationships of the natural and socio-economic elements, as well as of the factors external to the system. Landuse stores information on the past interactions of the above systems, too. "This model, when adopted to local conditions, will assist in the understanding of the mechanisms involved and will facilitate prediction of the responses" (MESSERLI, B., 1984: 90).

The Messerli-Messerli model was used for the exploration of the *Tajikabad test area* in the upland Pamir-Alai region of North-Eastern Tajikistan. This area is one of 4 test areas included into the Project "Tajikistan. Electronic Atlas of Regional Development Scenarios".

In our study of the Tajikabad test area we were seeking answers to the following questions:

– What was the role of the hazardous Khait earthquake of 1949 in the development of the region?
– What was the influence of the state policy of resettlement of the mountain population to the lowlands on highland geosystems?
– What was the cumulative effect of these two factors?
– How are the above factors reflected in landscapes/landuse, and in what way can these be incorporated into the development scenarios?

The test area is located in the western section of Pamir-Alai (Fig. 1). The territory includes the river valleys of Yarkych and Yasman (Surkhob/Vaksh river system) and a section of the northern slope of the Peter the Great Ridge. The range of heights is 1200 to 4800 m. Climate of upland valleys is semiarid, and local agricultural conditions depend on orientation of valleys and on slope aspects. The Pamir-Alai mountain system is a zone of high seismicity at the geological divide of Tien Shan and

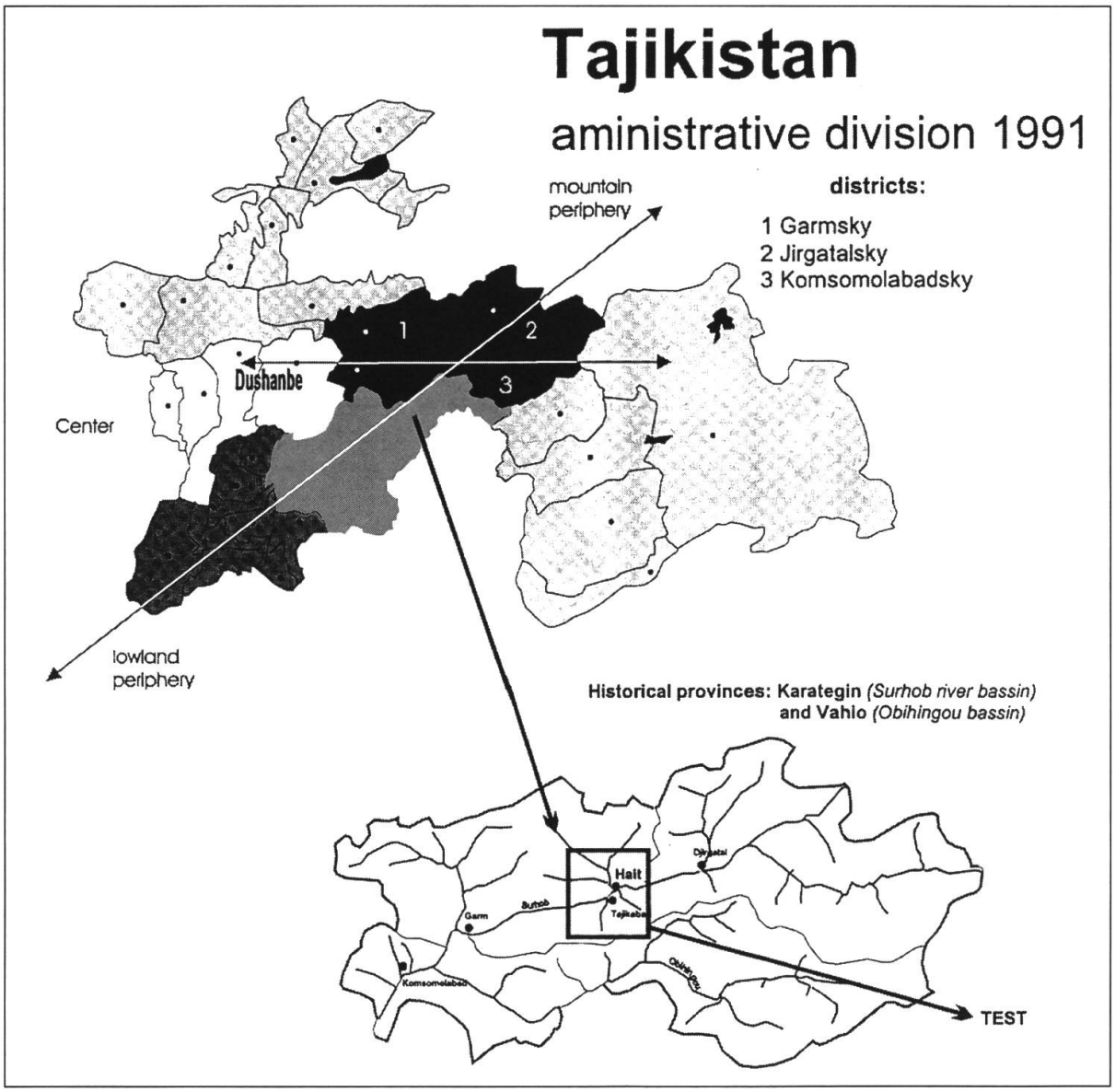

Fig. 1: Location of the test area.

Pamir. Active tectonic movements and catastrophic earthquakes account for the exogenic instability of the territory.

History of human settlement

150 to 300 years ago the Surkhob basin belonged to the Karategin province populated by Tajiks, who moved there being forced out from plains. The Tajiks brought with them sedentary agriculture and forced the Kirghiz nomadic tribes out of their traditional grazing grounds. Since that time the territory became the divide between sedentary Tajiks, who were practicing intensive agriculture, and nomadic Kirghizs. Military conflicts occured there periodically in the 18th and 19th centuries.

Under the centralized management of the Soviet period the region was transformed into the resource-supplying periphery of the growing administrative center of Dushanbe. However, this upland area posesses a lot of natural and human labour resources and a high development potential.

Traditional landuse

According to our assessments, this territory of 470 km^2 has sufficient resources to provide for a population of about 120000. 45% of the land below 2800 m can be cultivated. 15% of the land are excellent for agriculture. About 30% can be used for some crops under special agrotechonologies. The most favorable agroclimatic conditions are in the zone below 2500 m with 300–800 mm rainfall.

During the 300 years of sedentary agriculture in this region a vertical system of resource-use was formed. It developed due to human penetration in higher up valleys and to the introduction of upland crops. The centers of "dispersion" were the largest rural settlements *kishlaks* (Fathobad, Tajikabad, Khait, Garm), located in the bottom sections of the main valleys. Population migrated up the valleys to find free land for their growing families. New *kishlaks* were established at sites of summer grazing or "experimental" fields. Thus, the settlement system was densely interrelated with the vertical zones.

The resource use system included four vertical zones, integrated into one socio-economic system. River terraces and alluvial fans were used for community fields and vegetable gardens. The main agricultural activity was carried out in the bottom of the valleys and on gentle slopes. More than 15% of wheat and barley fields were situated on slopes and terraces. Highlands were used for silviculture and hunting in the upper part of the tree-bush belt, as well as for pasturing, and fuel wood collection in the subalpine belt. This organization ensured comprehensive utilization of natural resources of all vertical belts.

Traditional landuse was well adapted to local environmental conditions. This is evidenced by low erosion of the steep slopes where most of the cultivation took place. The factors which ensured this were advanced techniques of traditional land cultivation: terracing, irrigation, afforestation, in particular planting trees along irrigation canals – the *aryks*.

The key factor of sustainable agriculture was a set of rules, limitations, and penalties, i.e. the age-long traditions of resource management. Local communities implemented a control over observation of these regulations, performed by elected elders and respected citizens.

The overall situation was not so "placid": the harmony was violated by competition of landusers: *emir* (the state), *bek* (landlord), *mulla* (religious leader), and *dehkanin* (farmer). The mountain forests suffered most of all. By the end of the 19th century they were essentially cleared in the vertical belt from 1300 to 1500 m. The result was an overall xerophitization of landscape and the development of dry savanna.

Khait Earthquake

The Surkhob Valley is located in the highly seismogenic fault area of southern Hissar. In the 20th century, it witnessed two catastrophic earthquakes: Karatag (1907), M=7.25, H 28 km, and Khait, M=7.5 and H 35 km.

The greatest damage was caused by the Khait earthquake to the right slopes, where the regional center with a population of more than 30000 was located. The earthquake stroke on July 10, 1949. Two shocks followed each other, and provoked a strong rockfall and landslide in the Darahavs Valley (Fig. 2) which – within sev-

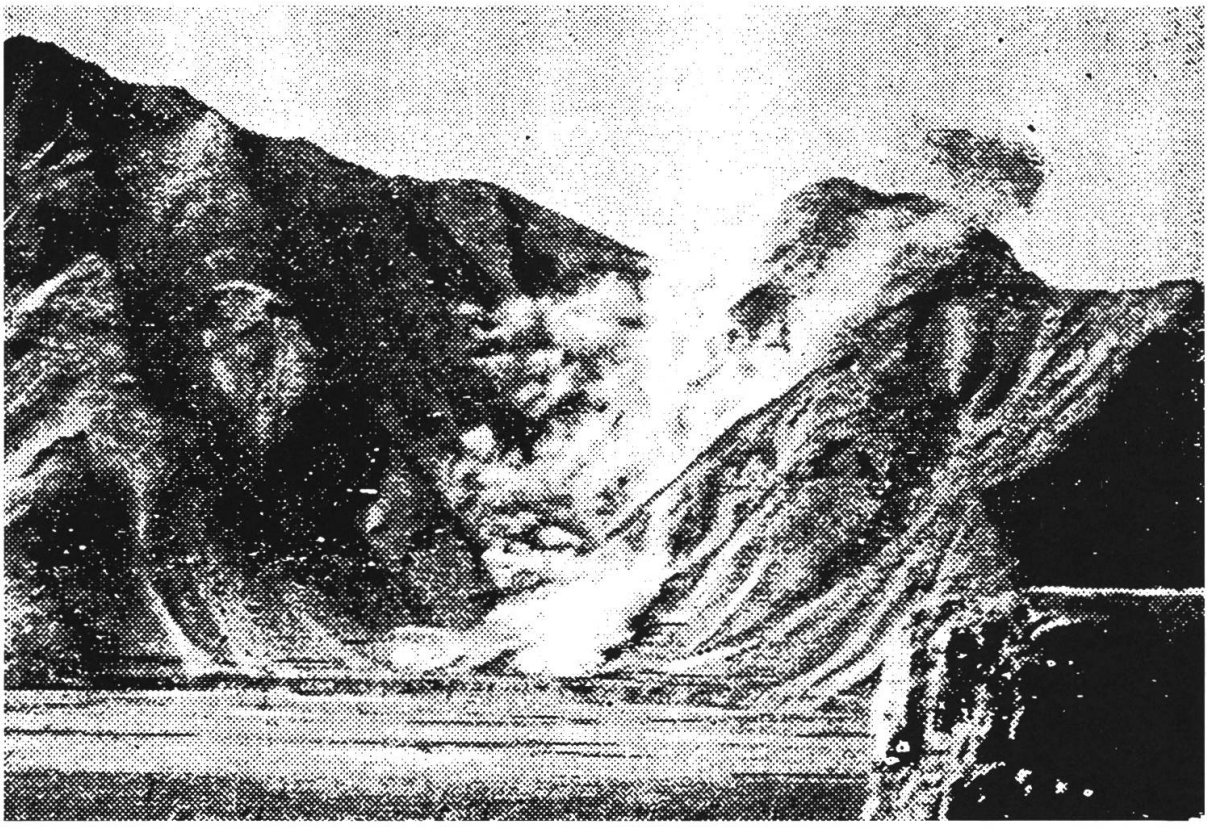

Fig. 2: Earthquake in Khait in 1949. Landslides from the slopes of Darahavs Valley buried the regional centre of Khait with its population of more than 30000. (Photo from: Staniukovich, K.V., 1982)

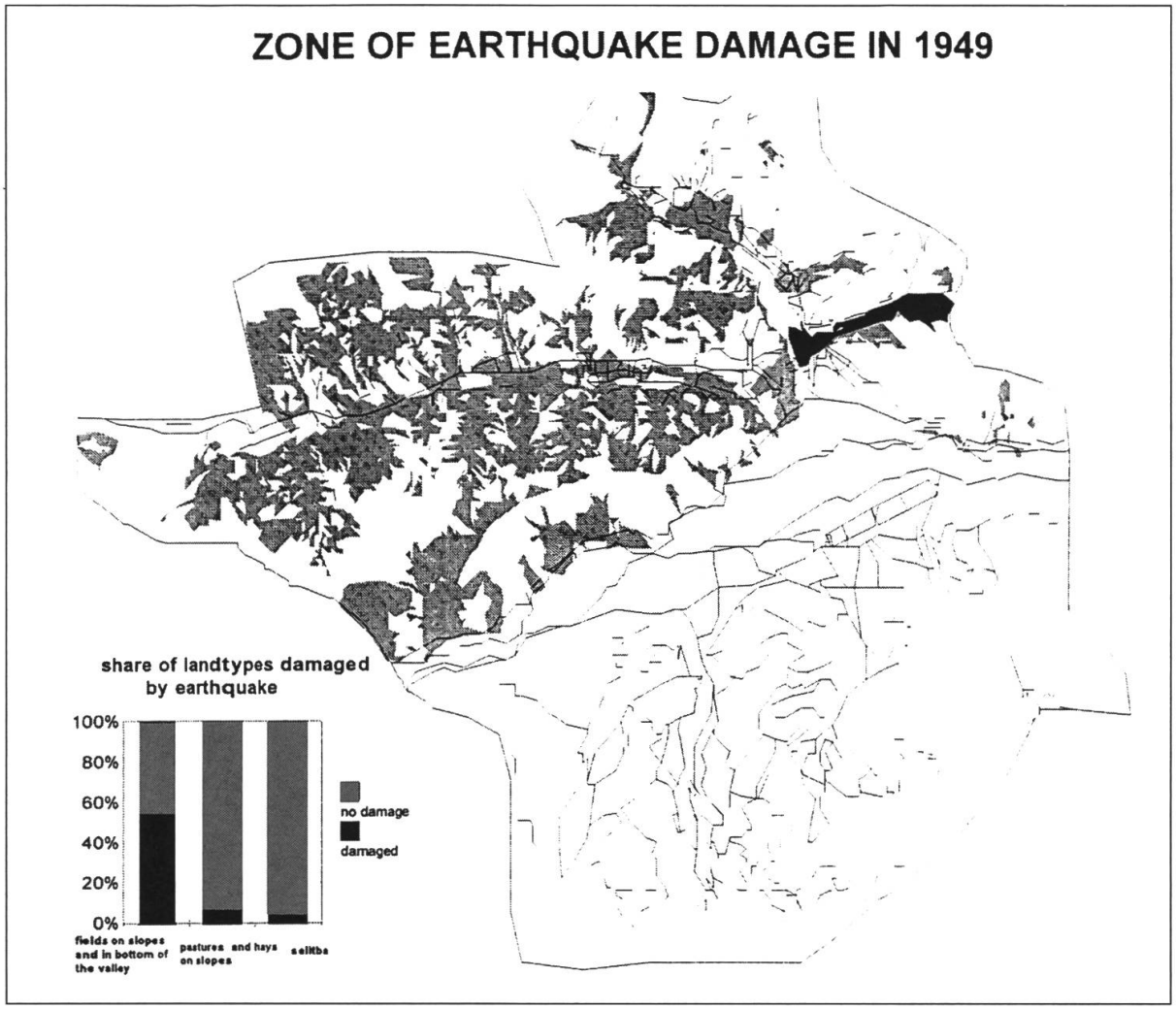

Fig. 3: Zone of the damage caused by the earthquake: 35% of the kishlaks, and 50% of the productive fields and irrigation facilities were severely damaged.

eral minutes – buried the administrative center of Khait. Practically all of its population was killed instantaneously. As a result, 35% of the *kishlaks*, 50% of the productive fields and irrigation facilities were severely damaged. Rangelands were also impaired (Fig. 3).

The *kishlaks* and the cultivated land on the left slope of Surkhob were not seriously damaged; the earthquake's magnitude was only 4–5 there. Only three *kishlaks* were severely destroyed in that area.

The Khait earthquake was an extraordinary event – an instantaneous impact on the ecological, economic, and social system of the region. In the man–environment duet, one of the two lost half of its population in a catastrophic event. The very fact of the Khait Earthquake and the number of its victims were never published. Therefore, the number of victims ranges from 20 000 to 40 000, according to various assessments. However, survival and adaptation mechanisms were in action. Airborne images, taken some time after the earthquake, clearly show the progress of rehabilitation activities: reconstruction of fields and irrigation networks, construction of new

paths and roads connecting the settlements which survived. One could expect that with time the ecological and economic system of the region will be restored, and resume the traditional development scenario.

State policy of depopulating upland areas

From the very beginning of the Tajik state, in 1924, its Government and the ruling Communist Party of Tajikistan pursued a policy of supporting migration of upland population to the lowland cotton-growing regions. Officially, the following goals were declared:

- supply of labor to the priority industry – production of cotton fiber (cotton self-reliance of the USSR),
- upgrading of living conditions of mountain people by providing them more comfortable lowland location,
- eliminating the risk of life in "environments subject to geodynamic hazards".

Eventually, the state migration policy was much more complicated and resolved several diversified economic and socio-political tasks. A thorough scientific analysis of consequences of this policy is still to be performed.

In view of the specific situation of the Khait region this migrational policy had rather dramatic consequences. The Law of the Five-Year Plan of Rehabilitation and Development of the Tajik SSR Economy in 1946–1950 stipulated that 7000 rural households be moved to the Vaksh Valley (ABDULKHAEV, 1988: 153). Statistics do not provide data on how many persons were resettled, but only on households. Therefore it is not possible to account accurately for the number of people resettled, since there is no information on the number of persons in each household. In 1949 it was planned to move 3300 households, however, 5347 were eventually resettled. The reason why outmigration was higher than expected was the Khait Earthquake (ABDULKHAEV, 1988: 160). Thus, the population affected increased tremendously, adding to the earthquake victims several thousands of these ill-treated by state policy of upland depopulation. The territory, possessing high agroclimatic potential and age-long traditions, lost nearly all its population. The Government even annulled the Khait region as an administrative unit. The rights to use the lands and pastures were transferred to the neighboring regions, and to those located tens of kilometers away. Development of the territory was "frozen" for several decades.

Effects of Cumulative Impact

As was mentioned above, immediately after the earthquake the survival and adaptation mechanisms of local communities came into action. However, the state migrational policy which in accordance with the MESSERLI–MESSERLI model can be interpreted as an external impact on the system, played a decisive role in the subsequent development of the territory.

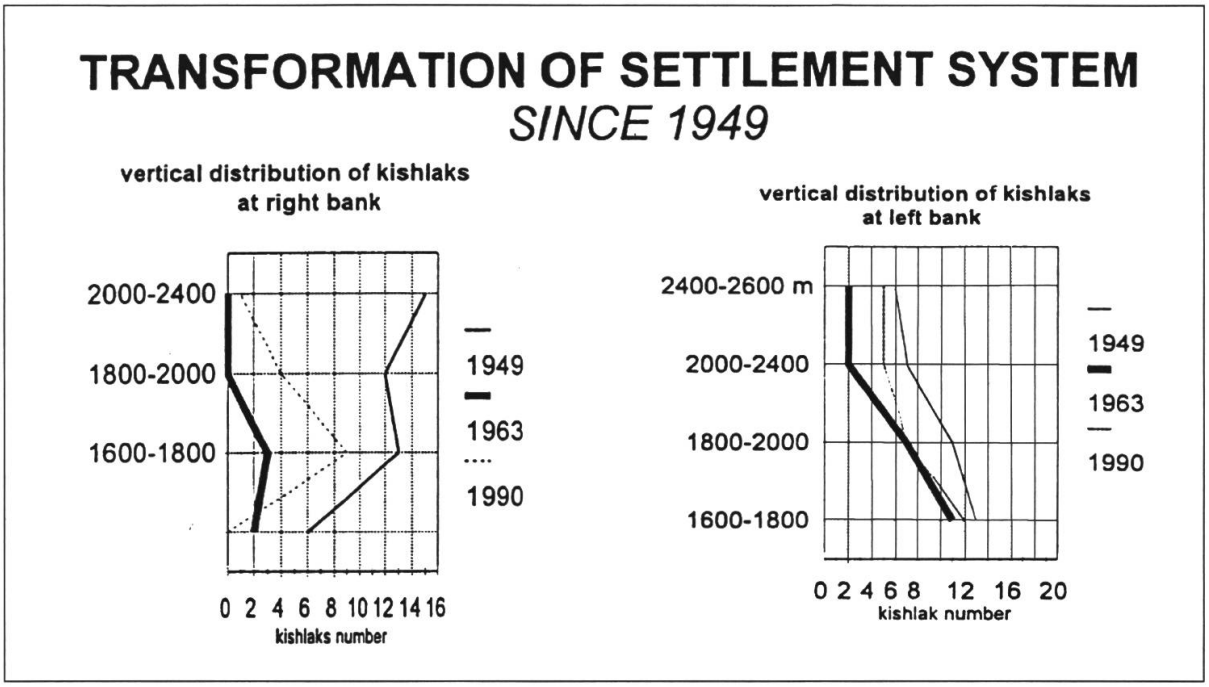

Fig. 4: The transformation of the settlement system since 1949.

Depopulation has hurt the whole of the Surkhob Valley, both its right and left slopes, from the areas most severely damaged by the earthquake to the upmost *kishlaks,* located above the Peter the Great Ridge. The settlement structure was changed (Fig. 4), mostly due to the reduction of the number of settlements in the uplands and along the Yarkych and Yasman valleys (Khait region). Before the earthquake the above valleys had a high population density.

The destruction of the upland *kishlaks*, including those that were not damaged by the earthquake, resulted in the destruction of the system of seasonal migrations of animals to summer pastures. This traditional form of intra-regional migration was replaced by planned shifts for grazing of big sheep flocks from remote lowland areas of Tajikistan. Only one fifth of the region's total area (440 000 ha) was allotted for local use. Uncontrolled grazing by animals severely damaged productivity of rangelands. Erosion increased (Fig. 5). Fallow fields were severely eroded by gullies, and the formerly productive land transformed into low-productivity rangelands and badlands.

Thus, the catastrophic earthquake, together with the state policy of depopulation of upland regions, have radically transformed the ecological and economic system of the mountain area. The traditional landuse and resource management systems, which agreed well with the vertical zones, were destroyed. They were replaced by the system of centralized planning, and most of the agricultural activity shifted down to lower sections of the Surkhob Valley. Landscapes were structured to form three landuse patterns:

1. intensively cultivated collective land located in the vicinity of local population centers and transportation routes,
2. uncontrolled and fallow privately owned land located in less accessible areas, and
3. upland rangelands and grasslands used by farms located outside the region.

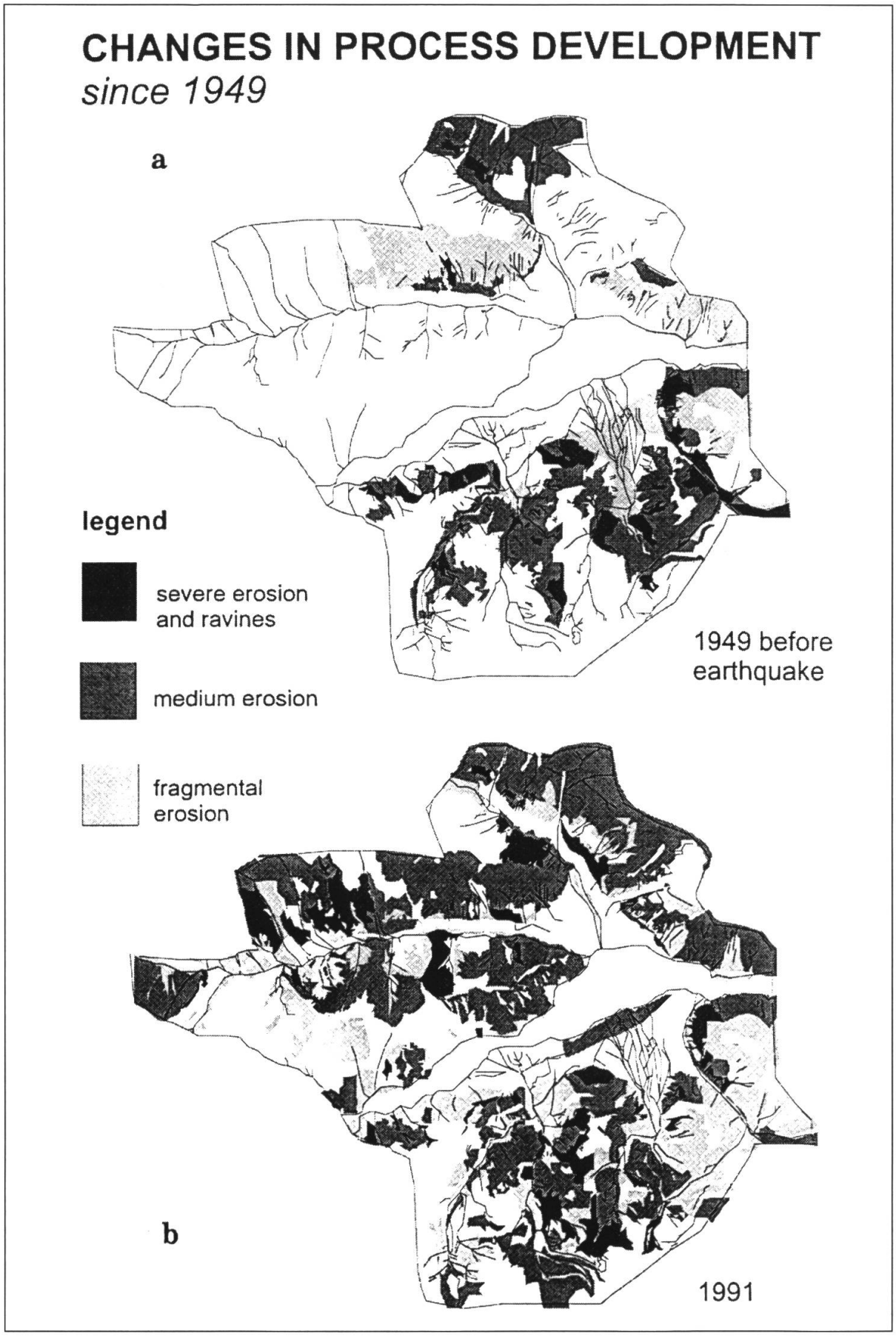

Fig. 5: Changes in the process development since 1949: Erosion increased.

Conclusions

The hazardous Khait earthquake of 1949 had significant impact on the environment and landuse systems. However, it was an isolated, though extraordinary event, and did not essentially change the traditional style of life of the local population. Airborne images of the territory taken some time after the earthquake clearly show that roads, fields, and settlements were restored.

The most important factor of transformation was the external socio-economic influence, i.e. the state policy of forced movement of the mountain population to the lowlands. Its devastating impact on the ecological and economic system was multiplied by the hazardous earthquake. The consequences of this cumulative influence are clearly "recorded" in landscape structures and landuse and population settlement systems.

These synchronous impacts shaped the development trends of this mountain region for several decades at least. The development followed the "marginal scenario" which was vividly reflected in landscape and in landuse patterns. The MESSERLI–MESSERLI model proved to be a very useful tool in this case. The theoretical as well as the practical potential of this model is far from being exhausted. The concept of sustainable development is a challenge to researchers and policy-makers who are working on upgrading the theory of development of complicated ecological-economic-social systems and on the practices of their management, one of the particular cases being the mountain regions.

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Personal

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Dr. Yuri Badenkov is Head of the International Mountain Laboratory of the Institute of Geography, Russian Academy of Sciences. Graduated from Leningrad University as geologist, he started in 1960 his research on geochemistry of ores. Later his research career migrated in along a complicated trajectory: geochemistry of landscapes, monitoring and biosphere reserves, geoecology of islands and atolls, geoecology and sustainable development of mountains. He conducted research in all continents, and in the Pacific and Indian oceans. He first met Bruno Messerli in 1986 in the Pyrenees during a field workshop of the IGU Mountain Geoecology Commission.

Dr. Irina Merzliakova is Researcher in the Institute of Geography, Russian Academy of Sciences. Graduate of the Moscow State University, Department of Geography. Her Ph.D. is devoted to the Khait Region of Tajikistan. She first met Bruno Messerli in 1990 during a field workshop in Tajikistan.

Yuri P. Badenkov and I.A. Merzliakova, Institute of Geography, Russian Academy of Sciences, Moscow