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Down the Memory Lane: Association of Polish Geomorphologists with India

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Prologue

It so happened that after 20 landings in India, my health does not allow me to participate in the 9th International Conference on Geomorphology of the International Association of Geomorphologists in 2017 to be held in India. Convener of the organising committee – Prof. Sunil Kumar De turned to me with an unexpected proposal to write accounts of my research in India and contacts with Indian geomorphologists. Intent of the organising committee is to publish the memoir as a volume of the Journal of Indian Geomorphology and release it during the conference. I was honoured by this proposal. As I feel connected with India, which I treat as my second homeland, I could not refuse the request of Prof. De.

The memoir, written spontaneously, contains both my scientific observations made in the Darjeeling Himalayas and in the Cherrapunji region, history of the Indo-Polish research collaboration, which I was fortunate to initiate, as well as my fascination with the culture and people of India.

I dedicate this account to the memory of my two friends who passed away: to Prof. Subhashranjan Basu, who was co-initiator of our collaboration and a great scholar of landslides and Himalayan valleys, and to Prof. Wojciech Froehlich, my student and teammate, who introduced new methods in the study of mechanisms of transforming the natural environment of mountains in a monsoon region.

I address my particular greetings to the organisers and participants of the 9th International Conference on Geomorphology and I wish the Indian colleagues further successes in learning landforms of their (and my) beautiful land.

Introduction

A dream to land at the foot of the Himalayas comes true

I spent my childhood in Dębica, a small town on the Wisłoka river at the edge of the Polish Carpathians, the northern most mountain range of Alpine orogenic system. In the middle Pleistocene, half a million years ago, the Carpathian margin was invaded by the Scandinavian ice sheet. Above cultivated foothills and forested low ridges, only a small Alpine-relief massif of the Tatra Mountain rises. In an extensive flysch zone, I studied mainly young Quaternary forms and present-day processes. It was my dream to see the Himalayas at least once in my lifetime. The ever rising highest mountains of the globe —

I did not expect that my dream will become true by more than 20 landings in Delhi.

In the spring of 1968, our small laboratory of geomorphology and hydrology in Krakow, belonging to the Institute of Geography of the Polish Academy of Sciences (PAS), got a message concerning a long-awaited exchange programme with the Indian Council of Scientific and Industrial Research (CSIR). Although the exchange programme was attractive, no candidate from our Warsaw head office was willing to participate in it, likely because a young generation of scientists preferred to visit western countries. I prepared my C.V. and a plan for a four-month visit to Northern India, from Assam to Kashmir, and waited for an answer.

At the end of November that year (1968), the International Geographical Congress (IGC) was to be held in New Delhi and I had also planned to attend the Congress with a group of Polish geographers. Till the end of September, I did not receive any answer from the CSIR. I had sent a telegram to Prof. S. P. Chatterjee, the then President of the International Geographical Union (IGU), asking for intervention.

In mid-November, having the Indian visa and vaccinated against cholera, I was changing flights in Beirut to avail the Air India flight for Bombay. Immediately after boarding the flight I was quite surprised and overwhelmed to see the way of greeting by two pretty dark stewardesses dressed in golden sari who welcomed us by exotic Indian music — the ritual which accompanied me till my last visit to India in 2009. In a few hours we landed at Bombay airport approaching from the sea-side. I came up with a wonder — where were the mountains?

After some rest in a hotel, I walked along the streets. The contrast between rich and poor was clearly visible. Suddenly, I heard a noisy tune coming from a hall across the street. At the door the brother of a bride invited me to participate in a wedding ceremony along with the family. I did not expect at that moment, that the invitation to this local community would bring far-reaching after effects: gradually I was being accepted in this great country, which I called later my 'second motherland'.

The first rendezvous with the Himalayas

From Bombay via Calcutta, we landed at Bagdogra, close to the campus of North Bengal University (NBU) — the university I collaborated with later on. Unfortunately, our flight was delayed and when we arrived, the congress participants had already left for the mountains of Darjeeling. To make-up for our delay, we rented a jeep. We ascended 2 km up along arable fields, tea plantations and a forest belt full of jumping monkeys. The road, from an elevation of about 400 m above sea level (SL), was winding up. We passed by villages with little Nepalese houses glued to the slopes. But our eyes were focussed on the images of an extensive catastrophe triggered by the downpours of 2–5 October 1968. Mudflow covered steep slopes, while debris flow deepened the troughs and transported down huge boulders of some meters in diameters. There were evidences of rock fall and debris sliding both above and below the road and larger landslide scars could be seen from a distance. We were passing by settlements with small shops and accompanying full-blossom bushes of *Poinciana regia*. Above, there were planted forest with protruding stems of *Cryptomeria japonica*. At places, the road followed the ridge axis from which small paths diverged steeply downhill towards tea plantations and to nearby tidy villages of Nepalese workers. On the green background of plants, numerous pale patches of mudflows, sometimes ravines, evidenced the size of the catastrophe. Finally, at a far distance it appeared — the huge

massif of the silver-coloured Kanchenjunga, sitting like a hen embracing chicks under her wings.

After crossing the pass in Ghoom (2,250 m) we went slightly down and the panorama of Darjeeling came to my view. The western and southern slopes of the ridge arc were densely built-up with 2-4 storied buildings set along winding streets. Some of those buildings slid down-slope during a previous catastrophe in 1950. Below, there was a crowded market-place, a narrow-gauge railway terminal with a fuming roundhouse and above the roofs of the houses protruded spikes and cupolas of shrines and temples of various Asian religions.

We stopped overnight at the top of the ridge in the Tourist Lodge, from where there was a wonderful view of the Kanchenjunga. I woke up before sunrise. Behind the winding path of the northern slope there was a 'world-unique' view of the 8–km panorama of the highest mountains of the globe, still in murk. From duskiness the silver-glistening Kanchenjunga was coming slowly into view. The colours of the mountain were changing from silver into pink, then into red and golden. After an hour, daylight started to penetrate the valleys (Photo 1). Life awoke with morning birds singing their songs. From the distant Buddha temples monotonous tunes of drums and bells could be heard. It was the time of morning prayers. From deep valleys descending down to 300 m, white morning fogs were rising up. Over the horizon, the luminous Kanchenjunga stands all the time – allegory of a mother. It was time to return to the lodge after the marvellous view that revealed the morning mystery. The view I had the opportunity to admire many times later.

The pre-congress symposium sessions were held in Loreto Women's College. The local intellectuals participated in the symposium to listen to the disputes on the history of the mountains. Some individuals promised me their participation in joined research projects, if I were to come for a longer time span. Not everyone was such men of word as those of forest service or the association of tea planters.

The field trips planned for the symposium had to be limited because the roads, apart from those from the lowland to Darjeeling, were still impassable. The road leading to the Tista valley was the only one which was operational.

In the evening, I sat at the desk to write a report of my first meeting with the Himalayas. I handed in the text to my countrymen who were already returning to Poland after the Congress. My text was published in a geographical magazine *Poznaj Świat* (Learn the Globe) of Warsaw Printing Hall in the volume of April 1969 which almost coincided with my coming back to Krakow. The report was illustrated with 2 photos and a map, but it could not avoid some numerical misgivings, likely as it was much before my detailed studies were carried out. The nature was returning to balance after the catastrophe at a greater pace and the men cured injuries faster than I thought at that time.

The International Geographical Congress in Delhi and the programme of my first visit in India

I travelled from Darjeeling to Delhi deeply convinced that I had to modify the original outline of my four-month visit as to come back for a longer stay in Darjeeling in order to undertake examination of the catastrophic downpour.

The Congress, held from 30 November to 5 December, was perfectly organised under the chairing of Prof. S. P. Chatterjee, who was the Head of the National Atlas Organisation (now National Atlas and Thematic Mapping Organisation) and whose terms as the President of the International

Geographical Union were coming to an end. For the opening ceremony of the Congress, Mrs. Indira Gandhi – the then Prime Minister of India, gave a rousing speech on economy and starvation problems in the world. I left the Congress sessions for a whole day to spent my time in the CSIR, making all efforts to convince them that my research programme focusing on the northern Indian Himalayas and their foreland, from the moist Meghalaya upland in the east together with Kashmir to a desert Rajasthan in the west, had to include the study in the Darjeeling region. The Indian clerks kept asking why I wanted to come back to Darjeeling if I had seen it already!

Finally, the approved programme covered two short post-congress symposia in Poona and Calcutta, linked with a visit to the Geomorphology Department in Technical University (Polytechnic) in Karanpur, and then a two week long stay in Darjeeling during Christmas and New Year. Later, I voyaged to Assam, from the margin of the Himalayas across the Brahmaputra valley to the Meghalaya upland with the world-known Cherrapunji. On my way back to Delhi I stopped at Ranchi (at the edge of the Deccan), Varanasi on the holy Ganges and Lucknow with the unique Institute of Palaeobotany and Himalayan branch of the Geological Survey of India (GSI). I combined the visit in the western GSI branch in Jaipur with a trip to Sambhar Lake. I had an opportunity to see the desert margin and Aravalli mountains with help from the Central Arid Zone Research Institute. After the visit to the centres of geology and soil erosion studies in Dehra Dun, I was accompanied by the famous geologist C. P. Vohra on the trip across Siwaliks from Chandigarh to Jammu. Finally, just at the onset of spring I visited the Kashmir valley (Fig. 1).

The outcome of this first visit to India was a monograph on the results of the extreme rainfall in the Darjeeling Himalayas and characteristics of Indian climate with reference to relief-forming processes (Starkel 1970, 1972 a, b).

Figure 1. Areas of studies and places visited by the author in India. 1. Region of detailed studies, 2. Research centres visited, 3. Region studied or visited on the route, 4. National boundary

Darjeeling Himalaya

The initiation of studies on the downpour in the Darjeeling Himalaya

During the Congress of the IGU in Delhi, I devoted a whole day to persuade the CSIR that I had to go once more to Darjeeling, at least for two to three weeks, to undertake field studies on the results of the downpour. I was convinced that I would not have to do it all on my own, as one Geography teacher of a college, one Professor of Calcutta, and the Head of the Forest Services in the Darjeeling District promised to accompany me. CSIR offered me accommodation in the Tourist Lodge with a wonderful view of Kanchenjunga. During my stay, one evening in December, it turned out that two of my companions would arrive later while the forester had to attend another meeting in Kolkata. A bit upset with the lack of transportation means, but equipped with a geologic compass and altimeter in my pockets, I walked along the central street as to notice an old wooden building of the Planters Club with an inscription "Darjeeling Planters Association". After a long and fruitful conversation there I left impressed with a collaboration to be undertaken. The Planters selected four seriously damaged plantations as working lots; they provided me with free transportation, accommodation and board as well as the rainfall data and cadastral maps, on which I had to mark landslides and changes of stream channels (Photos 2–8). In return I promised them a written report based on the summary of my observations and conclusions. We were God-send to each other. It has to be noted here, that after the downpour of 2–5 October at the end of monsoon, when it rained approximately 1,091 mm in 52 hours (in Kurseong), there was no more rainfall. The weather was respectfully awaiting the guest from Poland, leaving sediments and landforms untouched after that catastrophic event. There were plenty of evidences to work on — hundreds of earth and debris flows, small and large landslides, widened stream channels, broken bridges buttressing up to 10 m, high off-side accumulation etc. In Pul Bazar the market square was covered with debris which buried almost 200 people.

Later on, I managed to get other crucial information. I obtained rainfall intensity data from two recording stations; forest servicemen took me along for the inspection of forested areas which were mostly undamaged. Mr. Das — a photographer from Darjeeling, made the pictures of previous catastrophic downpour of 1950 available to me for comparison; while the catholic Bishop Benjamin, who organised help for the catastrophe victims, made the same with his press extracts.

An Indian periodical on nature protection published my small article on the catastrophic downpour in 1970. A similar note was printed in the popular Polish geographical magazine *Poznaj Świat*. The detailed research study on the downpour and its effects on the natural environment was published in English in the scientific journal Geographica Polonica, which was distributed during the International Geographic Congress in Montreal in 1972. This paper, as one of a very few papers on extreme events in the Himalayas, became a milestone at that time.

The catastrophic rainfall at the margin of the Darjeeling Himalaya

The barrier of the Himalayas together with the Tibet cannot be crossed over by cyclonic systems travelling onshore from over the Indian Ocean. The sharp crests of the mountains in that area, rising from 100–200 m to 1,500–2,500 m above SL generate precipitation exceeding 5,000–6,000 mm a year, which is the highest in the Himalayas. In the recent history three rainfall events related

to advances of cyclonic systems to lower parts of the mountains have been recorded, when 2-3 day precipitation exceeded 1,000 mm (in 1899, 1950 and 1968). The last of the events is specific as by the termination of the monsoon, the precipitation of 1,000 –1,200 mm was recorded for 52 hours on 2–5 October 1968. During the last 4 hours of that rainfall, precipitation of ca. 200 mm was recorded in the Darjeeling tea district (Fig. 2). Then, no precipitation exceeding a few mm was registered — all damages on slopes and in valley floors awaited my undertaking of field studies!

From the analysis of data from dozens of rain recording stations it is apparent that differentiation in precipitation total is much more dependent on aspect and distance from the mountain margin rather than on absolute elevation. On northern slopes of marginal ridges precipitation is lower, at least by half than the south exposed slopes. In the mountains interior, at a distance of 30 – 50 km from the fringe, annual precipitation declines from 5,000–6,000 mm to less than 1,000 mm.

Besides the long-lasting precipitation, such as that of 1968, short term heavy rainstorms related to convection on front faces of the outer ridges are likely to happen. A three hour long downpour in the Mahananda catchment on 7th July 1998 was of this nature. At that time rainfall was 358 mm and a debris flow triggered in the nearby trough put into motion boulders of up to 10 m in diameters (Photo 9) and destroyed the only road leading to the tea plantation. A few days after the rainfall, we struggled to Jungpana plantation through the gorge in order to register a scale of detriments. The plantation was cut-off from commodities for some days and all supplies had to be delivered by a helicopter (Starkel, 2004).

Our first field station in Bannockburn Tea Estate.

Bannockburn Tea Estate is located almost 10 km northeast of Darjeeling, on the left steep slope extending from 700 to over 1,800 m above SL and descending to the Rangnu stream valley. Over the wooded

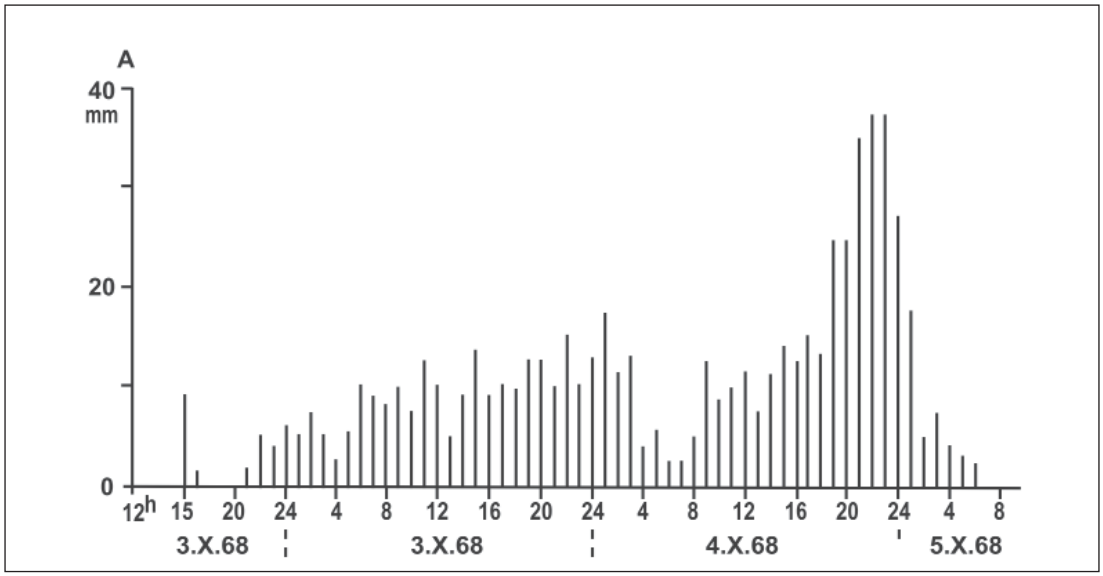

Figure 2. Rainfall intensity per hour during continuous rain of 2–5 October 1968 in Kalimpong-Darjeeling Himalaya (Starkel, 1972 a)

valley floor, tea fields cover the slopes. The slopes are dissected by short steep segments and two relatively small, flat segments where plantation buildings and Nepalese settlements are located. The Nepalese with their families work there for generation. After the rainstorms, the slopes were ploughed by debris flows, in places starting with piping tunnels (Fig. 3). On steepened drops, new slumps appeared. A few, vegetated, niche-shaped chutes were explained to me as traces of the earth flows of the previous catastrophe of 1950. The whole, up to 50 m wide channel of the Rangnu valley was mantled with gravel and huge boulders with up to 10 m long axis. On the bends, the chute, which was the debris flow track, was accompanied by steep rock undercutting.

Many years later, in 1984 when we started regular investigations under collaboration with the Indian National Science Academy (INSA), we, together with Wojciech Froehlich and Eugeniusz Gil, selected Bannockburn as one of our main base research sites. The first endeavour was geomorphic mapping using the cadastral map of the tea plantation and comparing the results with my registration of 1968 (Photo 3–5). We evidenced that plants overgrew the chutes which were filled with 1-2 m thick weathering material reaching to bedrock. We extended measurements of grain size composition and permeability of weathered metamorphic rocks — the task which I have initiated. We brought a pluviometer that served us to record the amount and intensity of precipitation especially during our summer stays. We measured infiltration and surface runoff being almost equal to zero on the slopes covered with tea-bushes. We finally found out the mechanism of water circulation and the reason for lack of erosional rills — real indicators of surface runoff. During the rainfall of 1968, all water was infiltrating into a silty-sandy weathering cover. An increased intensity of 1 mm min^{-1} in the last hours of the rainfall resulted at first in piping outflow, and then in liquidation of the entire weathered mass. The flows covered about 20–30% of the slope surfaces in addition to deeper, landslides of varied sizes (Fig. 3) that formed in susceptible geological settings. Inspections with the forest servicemen in December 1968 showed that the forest canopy protected well against erosion. Landslide affected areas usually did not exceeded 1–2% of slope areas and were mostly concentrated along roads.

We visited the Rangnu stream valley several times. It was a path for the debris flow in 1968, but years later the stream incised only a shallow channel. The flood-bed had been overgrown with forests and tall grass. For three years we carried out levelling measurements there and took photographs of debris to show the maximum grain size of transferred material. It varied from just 20 cm in one season to 50 cm in another one.

Chongtong and Pul Bazar on the Little Rangit

The Chongtong plantation located on the slope descending to a wide valley of the Little Rangit, was one of the four plantations that were seriously damaged by the catastrophic flood and selected by the Darjeeling Planters Association for my examinations. From the Chongtong Plantation Manager's house, where I was staying, it was an impressive view of a wide amphitheatre-like valley that had been ploughed by earth-flows, landslides and troughs (Photo 3), while at my feet there was a valley floor littered with boulders of all sizes (usually 1–2 m). The floor was widened 2–4 times in places (to over 200 m!) — alternations that I registered on the cadastral map and topographic maps, not mentioning air photos, which were hush-hush to a resident from a socialist country (Starkel, 1972a). From a remote distance I was able to notice the girders of the bridge which were

cut-off from the slopes by erosion and which slightly stuck out above the boulders. Behind the bridge there were partially destroyed houses of Pul Bazar. The bridge was 10.67 m (35 feet) high. It meant 10 m aggradation in a singular rainfall event! The surface was not graded. There were two distinct huge bars, likely to be former levees of the debris flow (Photo 6).

I went upstream the Little Rangit river. The channel was incised 7 m deep. The alluvia was fresh as they were deposited a day before, sometimes clearly bedded and imbricated. Suddenly, in the middle of a profile, I noticed a 2 m thick packet of chaotic boulders being typical of debris flows. I tried to rationalise the sequence of events. The intensity of the October rainfall, as recorded at the 15 km distant station, had increased only in last few hours and may be over the Rangit a bit earlier. But aggradation up to 10 m and a local incision at the end — when did it happen? Was it may be after the rainfall catastrophe? When hundreds of years

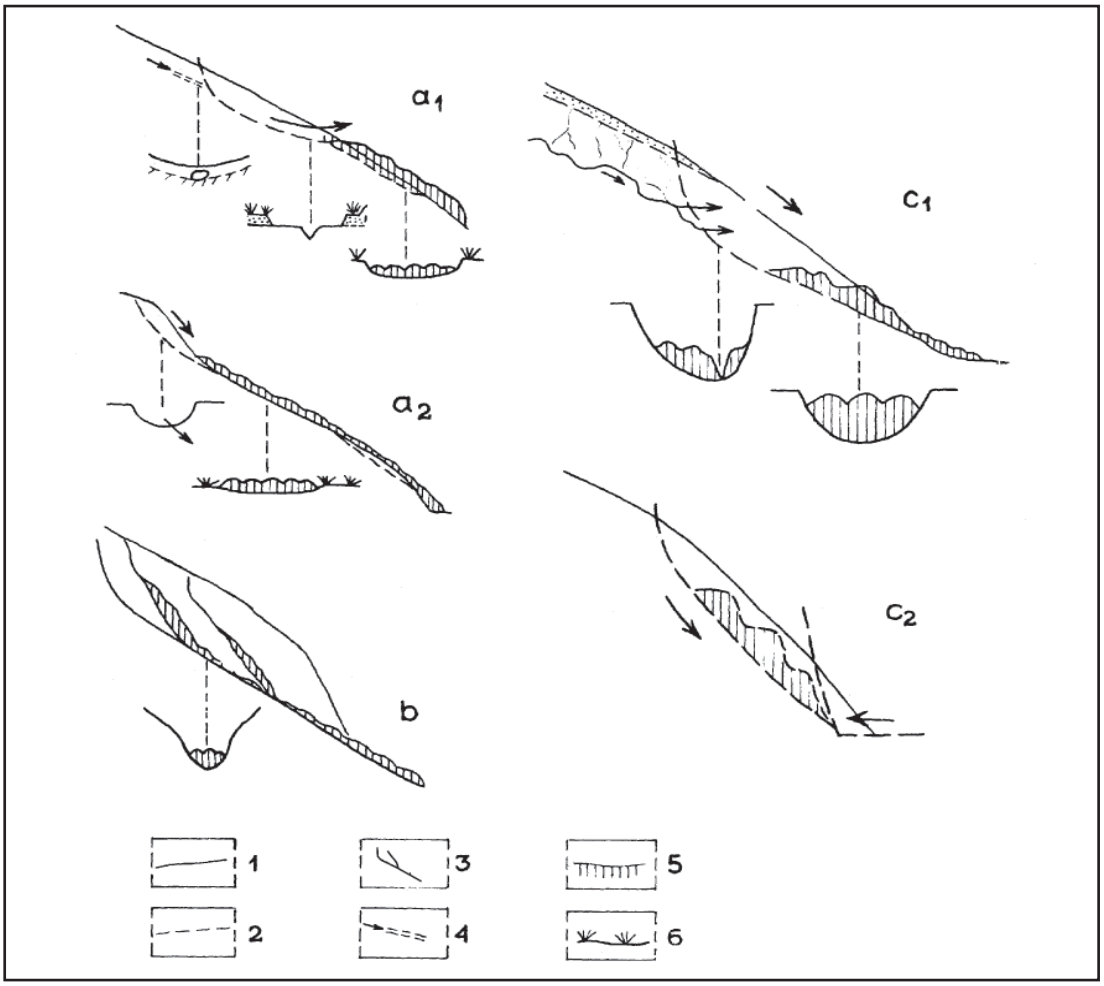

Figure 3. Types of erosion and mass movements modeling slopes in Darjeeling Himalaya during the heavy rain of October 1968. a1- mudflows and gullies connected with piping, a2 – slump-mudflow, b – debris flows in the gully channels, c1 – rocky slide connected with deep percolation, c2 – landslides created by lateral erosion; 1 – slope surface before movement, 2 – new profile, 3 – joints conducting groundwaters, 4 – sufosional channel, 5 – sliding mass, 6 – soil covered by tea bushes (Starkel, 1972a)

would pass after the event, it would be apt to assign sedimentation time and incision time of centuries to such profiles!

The bridge in Pul Bazar withstood the water pressure after the rainfall in October 1968. In December 1968, when I arrived in Pul Bazar, I still had an opportunity to observe high-water marks on walls of preserved houses. The higher cone of the tributary had been mantled with colluvium of the landslide that slid from a nearby steep slope. A broad oddly flat surface came to my sight. I was explained by the natives that the well-known market square was located there, close to the Nepal border. At the end of the rainy season, trade fairs were on. Unfortunately, the sinister incident caused the market place to be covered with landslide colluvium which had buried the stalls and approximately 200 people. No one counted the victims, there was no reason to dig them out, but definitely some of them were unknown traders from Nepal engaged in barter.

Twenty years passed. Together with Wojciech we were there again to survey the slightly incised Little Rangit channel. In Pul Bazar among the houses we saw the old market square full of life. Peddlers hawked their goods as before; but 12 m up on the side, a small plaque reminded about the catastrophe.

Transformations of the debris flow in Poobong

The Darjeeling Planters Association pointed out to me that the planation in Poobong at the Balasan springs was most seriously damaged by the October downpour in 1968. In the morning of Christmas Eve of 1968, I was given a lift to the manager's house by an old jeep. Together with a *chowkidar* (security) we walked 500 m down to the valley floor bypassing chutes of earth flows, which dragged the soil to bare rocks and transported hundreds of tea bushes down the valley. Some levelled out troughs evidenced the previous cataclysm. Finally we reached the valley floor. Where could have been the stream actually? All around there was ca. 20 m wide, irregular boulder-gravel surface with blocks having 2–4 m diameters sticking-up. One of the boulders was 6 m high and topped with another stone of 1 m in diameter (Photo 7). That was the high water mark. I walked over the surface of the debris flow and could see pieces of boulders (up to 2 m in diameter) chipped-off the huge blocks that had shattered when rolling. Farther down, the stream undercut the foot of the opposite slope. Amazingly, the plantation house still stood there.

In 1984, I came with Wojtek Froehlich and Jósef Sykstus to take the detailed levelling of the valley floor. The debris surface was overgrown with forest, whose canopy reached up to 10 m high. Along the debris flow axis, about 1–2 m deep trough, filled with water in places, was winding (Photo 8) through. The trough formed due to washing out the finer particles and subsidence of singular boulders. In the longitudinal profile there were several potholes and fine material graded the slope (Froehlich and Starkel, 1987).

What was the rate of the processes? In order to answer this question we repeated our levelling in 1989. At that time the forest formed a denser canopy. The channel was slightly widened but it was not deepened. In certain sections accumulation graded the channel slope. Some low channel steps had disappeared by this time (Starkel and Basu, 2000).

Will a deep V-shaped erosional valley ever be formed here? May be we will have to wait thousands of years when metamorphic gneisses crumble? Or may be we will face another catastrophe like that of autumn 1968?

Meanwhile, on that Christmas Eve of 1968, the sun was setting down when I had

finished my surveying, and I had to climb 500 m up. All of a sudden, among the bushes, I saw a Nepalese man leading a saddled horse — he was sent to me by the plantation manager. The man welcomed me and thanks to this 'salvage' I still managed to have my Christmas Eve supper in Darjeeling late in the evening.

Ambootia landslide valley

In 1987, together with Wojciech Froehlich we were invited by Mr. Bansal, the owner of Ambootia Tea Estate, to investigate the largest landslide triggered by the disaster of 1968.

The Ambootia landslide, developed during the October rain in 1968, is located on the left side of the Balasan river valley. The landslide body starts about 200 m below the ridge rising to 1,350 m above SL and runs 625 m down to the Balasan valley. The specific feature of the 'landslide-modelled valley' is its form and dynamic nature, which is a combined effect of gravitational processes and linear downcutting (Froehlich *et al*., 1992).

The area in question is built of gneisses and mica schist, dipping 30˚–50˚ towards north-northwest. The pre-landslide slope consisted of three parts — (i) an up-slope portion which was dismembered by shallow depressions and one deeper hollow; (ii) a flat mid-slope part at 900–950 m above SL occupied by colluvial fan built of 30 m thick silty-sand deposits with stony layers; (iii) a steep down-slope portion being also the valley side. Before 1968, the down-slope part was covered with shrubby jungle and bamboo, while the village with orange orchards and gardens occupied the mid- and

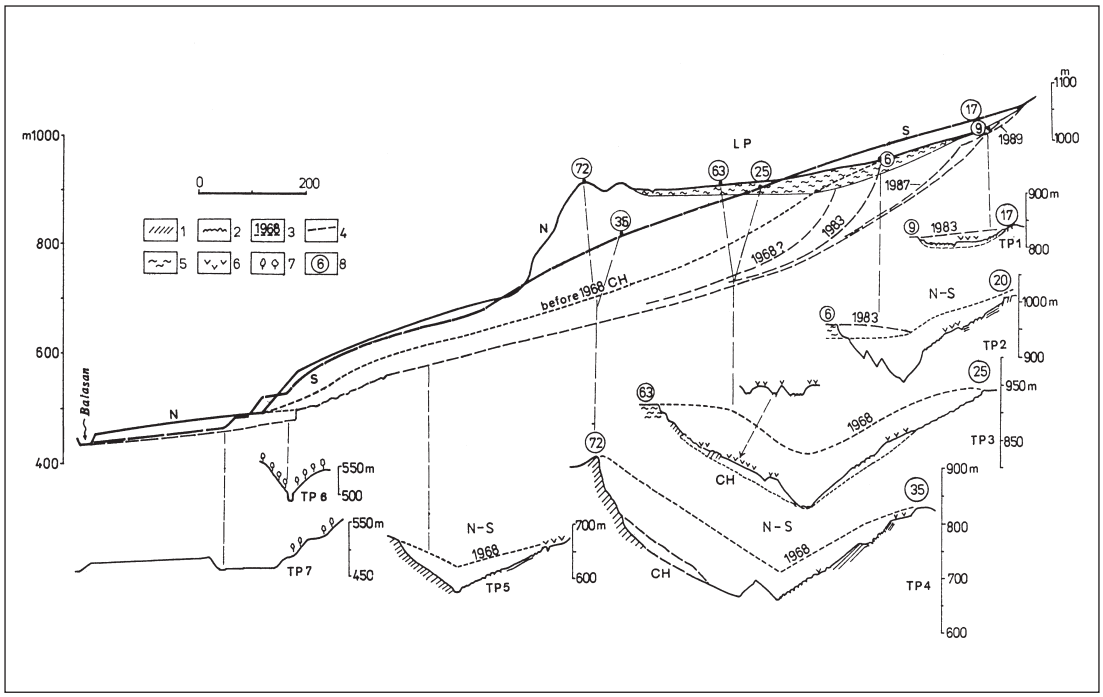

Figure 4. Longitudinal profile and transvere profiles (TP 1–7) of the Ambootia landslide valley (Froehlich *et al*., 1992). 1 – exposed bedrock, 2 – block fields, 3 – calculated surface channel profile before 1968, 4 – reconstructed channel profiles after October 1968, 5 – thick colluvial series, 6 – re-vegetated slopes, 7 – jungle, 8 – reference points

up-slope parts (Fig. 4).

The Ambootia landslide stretches for 1,300 m. The head niche begins at 1,065 m, while the fan zone begins at 480 m. The landslide depth increases from 10–20 m in the upper part to 200–270 m in the middle and drops to below 100 m in the lower part. The entire form now has a shape of a gully-canyon cut down in bedrock and is characterised by a steep gradient and waterfalls. The slopes of the gully-canyon are modelled by various mass movements. The uppermost part is subjected to slumps and slides of 10–20 m depth (Photo 10, 11).

The northern right slope in the middle part is cut in colluvial deposits, with the chutes of debris flows cut down into bedrock. The central down-slope segments of the right slope, above 300 m, are just rocky walls (Fig. 4).

The floor of the main gully-channel changes every year. Although characterised by large boulders and waterfalls, the floor is often transformed by frequent debris flows and rock avalanches. Springs, concentrating in two layers of colluvial deposits on the right slope as well as in the main axis of the landslide valley are also seen. Luminophores were introduced to the upper section of the stream outside landslide zone. After 10 hours, the coloured water appeared in the upper part of the landslide valley. It explains why upper part of the landslide valley is active insignificantly every year being supplied with water from outside the creek.

The present-day relief and processes indicate a complex history of various parts of the landslide area. During continuous rain reaching 890 mm, landslides (debris flows) were triggered. Powerful debris tongues hollowed out a channel at least 30–60 m deep. Approximately 10–15 million m^3 of material were partly deposited as a fan in the Balasan valley floor. Next acceleration of the mass movement and deepening of the main channel were caused by continuous rains (400 mm) during 25–30 June 1983, when many houses and road sections were damaged, while the colluvial fan in the Balasan valley was built up again. In the year 1989 we performed the detailed survey of the landslide valley (Froehlich *et al*., 1992) (Fig. 4). From 1989 to 2009, I visited Ambootia several times. The rainfall data for last 20 years did not evidence any spectacular events.

During last visits, the geomorphic parameters of the slopes did not change significantly — the slopes had reached the stage of unstable equilibrium. However, any extreme rainfall may cause some changes in their morphology. Between 1989 and 2009 the continuous progress in vegetation succession over the surface have been noticed. In 1996, about 80–90% of the landslide area was covered by relatively dense vegetation cover (Photo 12, Starkel, 2010).

In the future the landslide valley of Ambootia will likely reveal as a great scar on the mountain slope. In the Darjeeling Himalayas there are many such inactive scars on the slopes; even just at the opposite side of the Balasan river a similar niche is present. The continuous observations in Ambootia led to the conclusion that, though the major landslide scar occurred after the catastrophic event, for the landslide to attain its final form, relaxation time and long-time transformation may be also important (Froehlich *et al*., 1992, Starkel, 2010).

Complex history of the lower course of the Himalayan sector of the Tista river

The Tista valley above its junction with the right bank tributary Great Rangit is wide and winding. Close to the junction, the valley becomes narrower and takes the form of a canyon with steep sides and flattened top at 200–300 m above the channel (Photo 13). The Great Rangit transports large amount

of debris, about 1–2 m in size, that are characteristic of debris flows described from the Little Rangit and Rangnu catchments, which are known to be of high precipitation areas in the marginal part of the Darjeeling Himalayas. This part is also known as an almost forest-less area occupied by tea plantations and is well documented in the old photographs taken in the lower course of the Great Rangit in the 1870s.

Below the junction, the Tista river carries less and less debris of boulder size and its small tributaries supply mainly gravel-sized load. These gravel materials form alluvial fans as seen at the mouth of the Kalijhora. Passed the mountain course (Photo 14), the Tista enters a narrow 3–5 km long canyon which not only points to the rock resistance but also to the tectonic uplift of the Himalayan margin.

The role of extreme precipitation is evidenced by measurements of the Tista flood at the beginning of October 1968. Before the flood and destruction of the Anderson Bridge in Tista Bazar (Photo 15), the recorded water level was 201.8 m above SL. In the morning of 4th October 1968, the water level exceeded 206 m and at 11 am it reached 228.6 m above SL, which denoted a rise of 26.8 m (Fig. 5). The discharge was calculated to be 18,150 $m^3 sec^{-1}$. A normal water level in dry season by the end of 1968 did not exceed 207 m above SL. It denotes that due to the materials supplied by the landslides and super concentrated flow, the river bottom accreted by 5–6 m during the flood. Measurements of water levels in lean flow performed in the 1970s showed that the bottom had been slowly lowering probably due to washing out of finer material and subsidence of large boulders. In this way, debris flows and landslides in the catchment stopped the process of channel deepening in the young upheaving mountains.

During the 1968 rainfall event, high water level damaged vegetation on higher terrace ledges. After 20 years, a new young forest grew up (Photo 16). The 8 m high fragment of a small fan at the Great Rangit mouth, evidenced about 70 cm thick sandy cover, according to Cs^{137} method was dated to be of recent decades (Froehlich, 2000). That sediment is undoubtedly of 1968, as the subsequent yearly flood levels have never reached so high. That is confirmed by vegetation cover removed from the steep slopes to 5–6 m above winter water level.

Are the traces of the last Ice Age near to the Tista river outlet from the mountains?

During the Last Glacial, when the vegetation zones in the Himalayas descended at an average elevation of 1000 m, the glacial tongues ran even lower downhill. That should have been reflected in glacio-fluvial accumulation also in the Tista valley (Starkel and Sarkar, 2014).

Above the mouth of the Kalijhora stream I found gravel-sandy alluvia on the terrace flattening, 60 m above the Tista channel. The scarp periodically undermined by the river revealed the terrace structure. On 20 m high rocky socle there was the gravel layer with boulders of 1–2 m in diameter. The gravel layer was overlain by a sand series with fine gravels, reaching up to the top. All together it was 40 m thick alluvium deposited in a narrow mountain valley! Analyses of sandy material by thermoluminescence method provided the dates of 47 ± 6 ka BP and 17 ± 6 ka BP for the bottom and top faces, respectively (Bluszcz *et al*., 1997). So that aggradation coincided with the Interpleniglacial of the last Pleniglacial in Europe. It evidences, to a broad extent, of glacio-fluvial and periglacial accumulation zone, reaching to the mountain margin. The question arises: when was the socle dissected? Was it likely during younger tectonic episodes which have been registered in the marginal zone of the Himalayas?

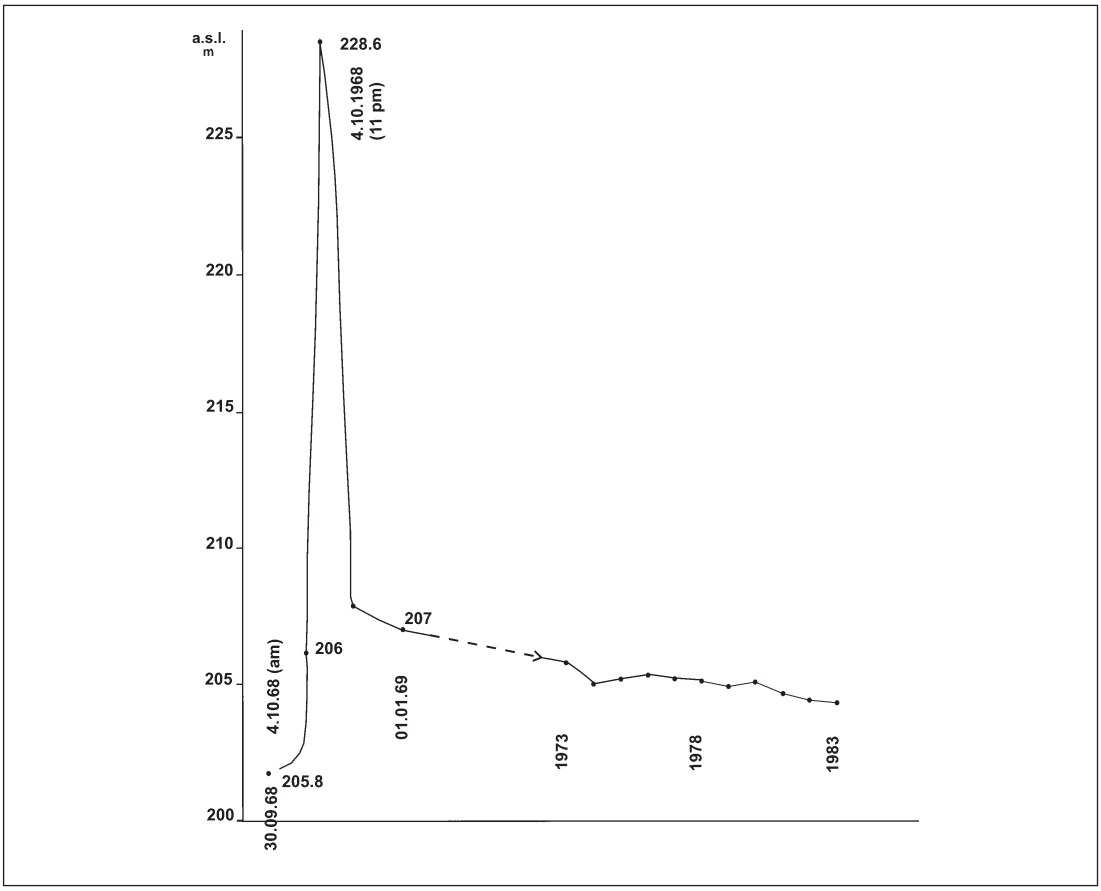

Figure 5. Fluctuations of the Tista river water level at Coronation Bridge before, during and after the flood of 4th October 1968; gradual lowering of lowest annual water level in 70s – 80s indicate a trend of deepening of river channel after previous aggradation of 5 – 6 m (after Starkel and Basu, 2000 and other sources compiled by author)

At the foot of the Himalayas

Alluvial fans of the Himalayan piedmont

In the 1990s we extended our study to the foreland and margin of the Sikkim-Bhutan Himalayas, where the sharp mountain edge is adjacent to the plain of the foredeep basin, and where precipitation gradient is high. That can be evidenced by a dense network of channels spread over tea-plantations (Fig. 6). The mountain slopes are dissected by rivers of various sizes. The largest ones, the Tista and Torsa rivers, have their springs in the High Himalayas and, also being fed by glaciers and snow, maintain their flow all year. The rivers bring their transported load as far as to the mountain foreland, so that their alluvial fans extend to the Brahmaputra river. Avulsion of the braided channels is observed during catastrophic floods, as it was the case with the Tista in 1787 and with the Torsa in the early 20th century. After those events forest vegetation had succeeded there, so the braided pattern was stabilised. We had an opportunity to observe it when crossing the palaeo-Torsa valley on elephant backs (Photo 52).

Smaller rivers, like the Balasan, Mahananda, Jaldhaka, with drainage basins of an order of 100–200 km^2, drain a 20–40 km wide belt of the Lesser Himalayas. Their

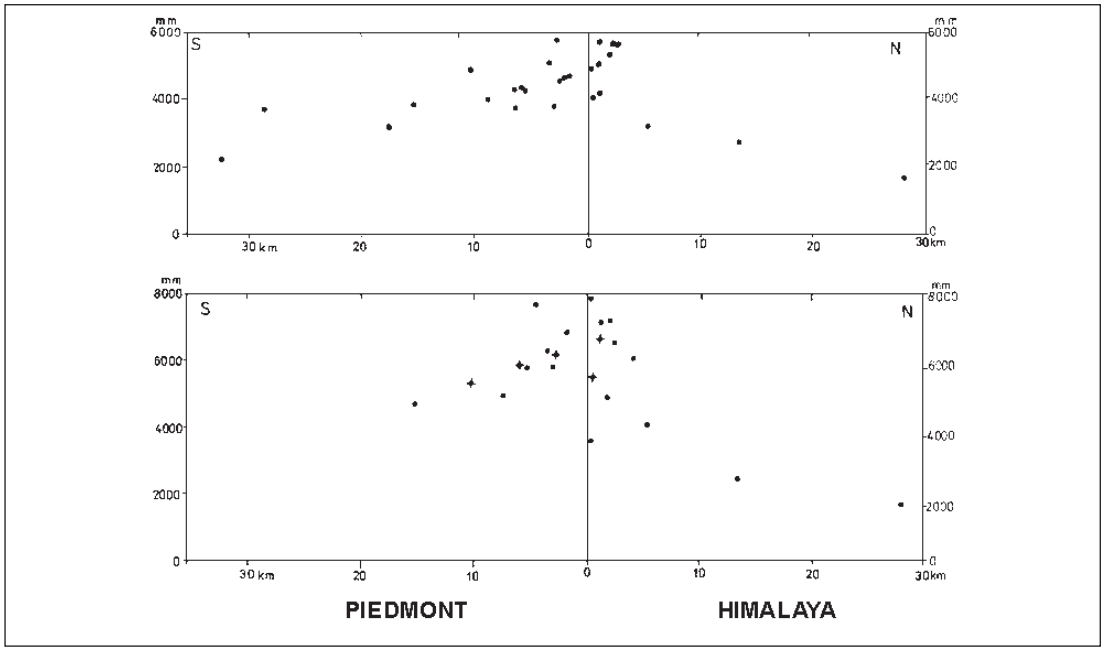

Figure 6. Mean annual rainfall (upper) and rainfall in 1998 (lower) along S – N transect of piedmont and margin of Himalaya (between Tista and Torsa) (Starkel *et al*., 2008)

hydrologic regimes are controlled by higher precipitation occurring there. The rivers having the smallest drainage basins (5–30 km^2) drain the fringe of the mountains, where precipitation gradient is the highest, diurnal precipitation are often 200–300 mm, and 2 to 4 days of precipitation amounts to 1,000 mm. In the last decade of the 20th century, five such rainfall events were recorded in 1993, 1996, 2000, and twice in 1998 (Starkel and Sarkar, 2002, Soja and Starkel 2007, Starkel *et al*., 2008). This is reflected in a supply of fresh debris and development of disproportionately huge fans, on which periodic streams often flows only by shifting their courses (Photos 2, 17–20). In this way, platforms of interlinked fans, sloping at 30–20% over a distance of several kilometres, are formed (Fig. 7). Debris accumulation is fast and channel bottoms accreted 2–3 m during the last 10 years, which makes people build new and higher bridges on transportation tracks (Photo 19). The fans enter the forest fringe, vegetation is unable to overgrow depressions and bars during a 2–3 year long pause in the material supply. Sometimes, the gravel mantle covers parts of tea plantations. Aggradation in drainage basins, where the supply from the slopes is significant, affects kilometers of the valley in to the mountain interior, e.g. aggradation along the Rehti valley (Photo 18).

The mountains are upheaving continuously. Fragments of the steeply sloping mountain edge are sometimes marked with huge landslides; their tongues often coalesce with surfaces of active alluvial fans (Photo 2).

In upper parts of the fan platform, water infiltrates through the alluvia to emerge lower down in form of active springs giving birth to permanent streams. These streams, with meandering channels, have a hydrological regime characterised by summer flood, which makes them similar to lowland rivers of the temperate zone (Photo 21). The examination

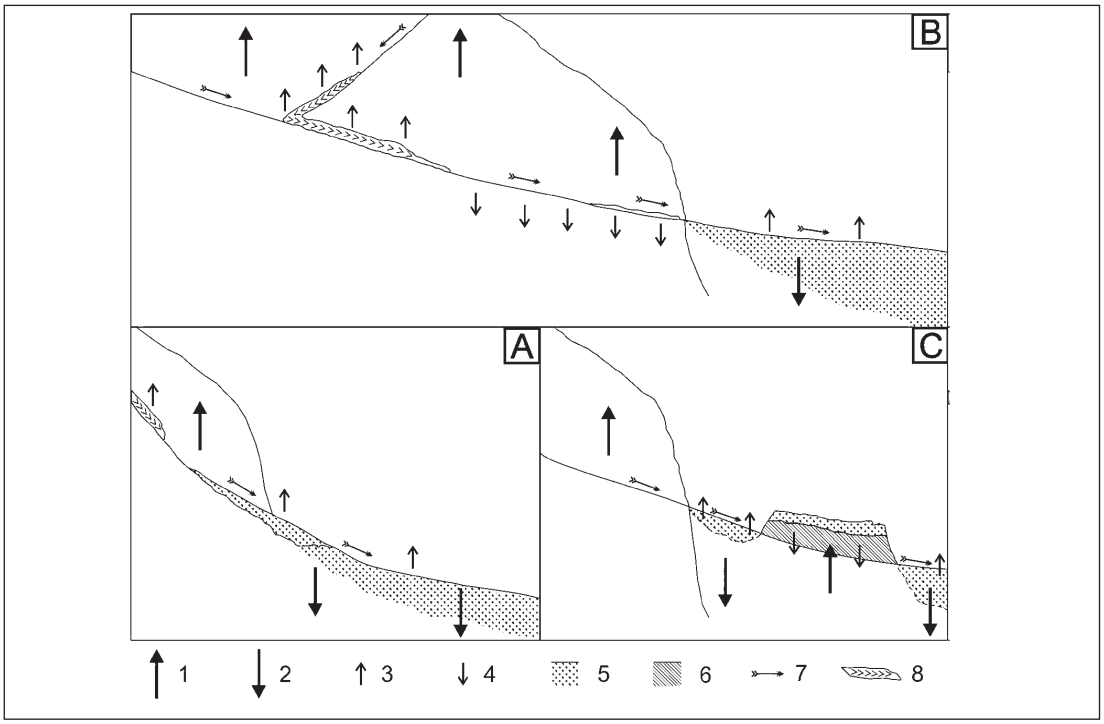

Figure 7. Longitudinal profiles of three types of river valleys at the margin of Himalaya (by Starkel). A – draining margin of mountains, B – large mountain river, C – rivers with antecedent sections in foreland. 1 – uplift, 2 –subsidence, 3– aggradation, 4 – down cutting, 5 – alluvial (fans), 6 – substratum (in uplifted blocks), 7 – runoff direction, 8 – debris flows

of the piedmont rivers was carried out together with Dr. Paweł Prokop, Prof. Roman Soja and Prof. Subir Sarkar.

Main Boundary Thrust and missing of the Siwalik zone

In the part of the Sikkim-Bhutan Himalayas extending between the Lish and Rehti rivers (east of the Tista), the youngest Siwalik unit building the main boundary overthrust of the Himalayas is absent. The piedmont zone with extensive fans forms a semi-circular apron. It includes several elevated, W–E oriented, flat blocks separated by alternated depressions formed along fault-lines. The upthrown blocks are built of coarse gravels covered by reddish-yellow mature soils, which were dated by OSL method to be of 50–60 ka BP (Starkel *et al*., 2015). They are elevated 50–65 m above the of main river channels. The middle terrace, 20 m high, was dated at 38 ka BP, while the lower fans, only 12 m high, were dated at 14 ka BP. The last one has less developed soil layer. Several rivers, like the Murti, Mal, and Kurti, flowing straight from the mountains towards south, are passing elevated blocks in antecedent sections and have higher gradient (Fig. 7, Photo 22).

The correlation with outlets of most eastern Himalayan rivers in Arunachal Pradesh, where Siwalik belt is wide and well developed, indicates active tectonic movement, vertical uplift and overthrusting that took place in two phases in the upper Quaternary (Lulrei *et al*., 2012) — the first phase was around 50 ka BP and second about 10–8 ka BP. The fringe of the Himalayas is deeply dissected by gullies and boundary thrust affects the alluvial fans of Brahmaputra's tributaries. Probably, the

area between the Chel and Rehti rivers was subjected to differential folding of the blocks than to overthrusting.

Shifting palaeochannels of the Torsa and other Sub-Himalayan rivers

It was identified that during catastrophic floods there was transformation of larger river courses by avulsions. This happened in the Tista river in 1787 and in the Torsa river in 20th century. In the early 20th century, two parallel branches of the Torsa were known — the western braided channel called Buri Torsa, and the eastern channel called Sil Torsa. The latter river was shifted to the Buri channel, and next avulsion to Sil Torsa followed, as indicated on the map from 1971 (Fig. 8). The abandoned valley of the Buri Torsa has been vegetated and drained by small creeks only (Photo 23). The great flood of 1998 caused lateral extension of braided channels of the Sil Torsa by undercutting the floodplain.

These observations and frequent catastrophic floods in the Ganga and Brahmaputra catchments turned my attention to one of crucial problems in Indian economy (Starkel, 1989, Starkel and Basu, 2000).

The Himalayas are rising several mm every year. On the other hand, the foredeep of the Himalayas is subsiding at a similar rate, flooding hundreds to thousands km^2 every year. The storage of water in large reservoirs in the mountains, which are subjected to

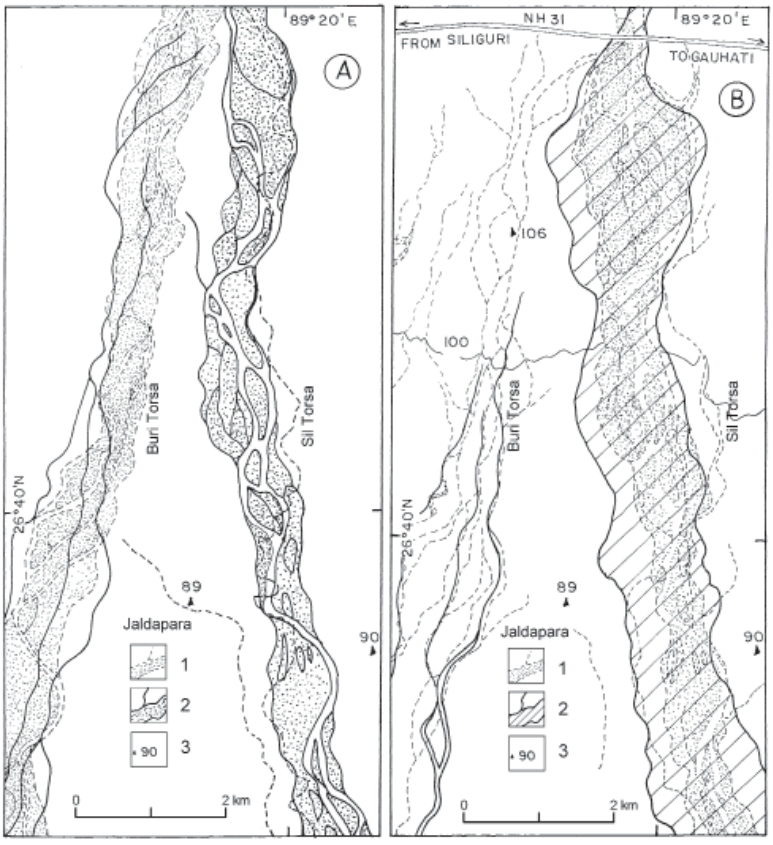

Figure 8. Changes of the braided channel in the Torsa middle course (elaborated. by S. Sarkar after Starkel *et al*., 2008). A – between 1929 and 1971, B – between 1971 and 1998. 1 – channel pattern with bars in 1929 (A) and 1971 (B), 2 – channel pattern with bars in 1971 (A) and 1998 (B), 3 – elevations in m

rapid siltation by debris flows, may reduce the expected damages in the plains only for few decades. Therefore, in the coming decades the government should consider an alternative construction of large polders allowing for free sedimentation in intended sectors, coupled with planning the shifting of settlements and arable land to another sector (Fig. 9). In the next century, successive exchange between three or four sectors should follow. The problem is complicated because it is concerned with a number of sectors — economic, social, as well as political and moral. The scientists should persuade the authorities as well as local population into believing that we cannot stop the continuous tectonic subsidence at the foreland of rising mountains and simultaneous aggradation.

Land of the highest rainfall on the globe

Barrier of the Meghalaya plateau

Between the eastern Himalaya foredeep, used by the east to west flowing Brahmaputra (Photo 25) and the immense delta of the Ganges and Brahmaputra (the Bengal lowland) there is an asymmetric tectonic horst of the Meghalaya plateau, which rises over 1,900 m above SL. It slopes steeply southward to the Dawki fault. The horst, built of crystalline and metamorphic rocks (that was intervened out by granite and basalt intrusions many times) in its southern part is covered with sedimentary Cretaceous and Tertiary deposits, among which coal, limestone and iron ores are present (c.f.

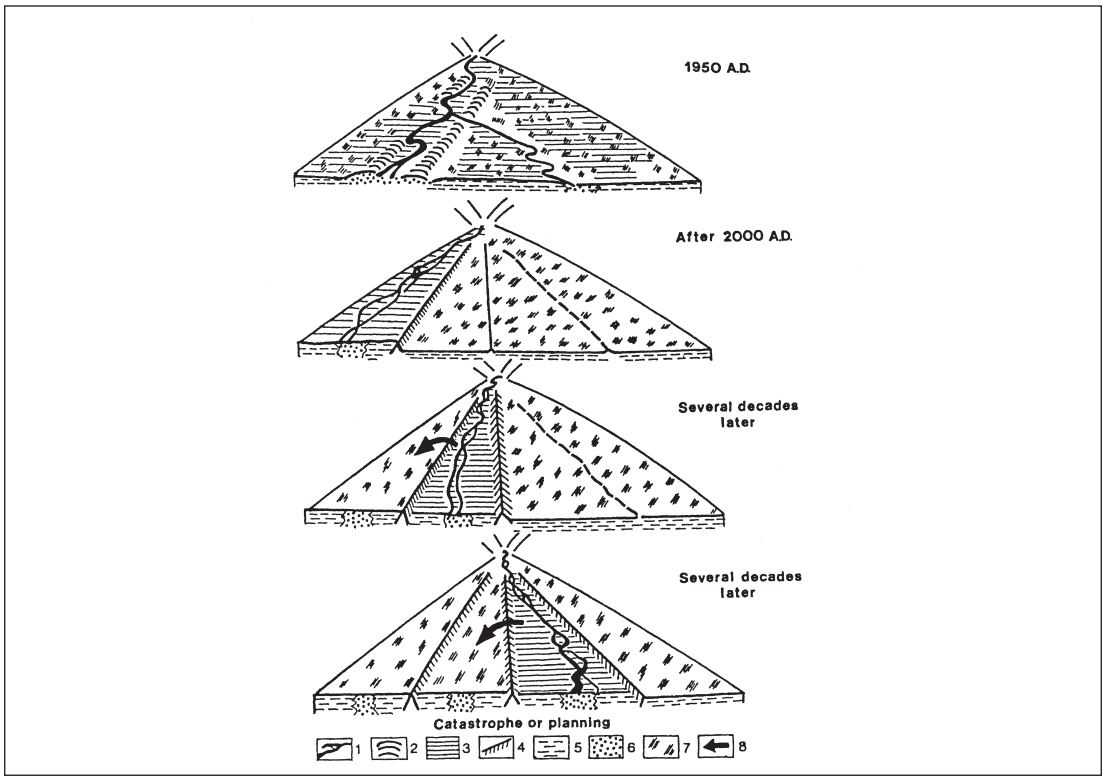

Figure 9. Possibility of the use of catastrophic floods for economic development exemplified great alluvial fans in the subsiding Himalayan foredeep (flood in 1950 covers extensive areas, future floods should be restricted to stripes which will shift in time and will be combined with the shift of settlements). 1 – river, 2 – levees, 3 – areas flooded during extreme floods, 4 – dykes, 5 – aggradation in overbank facies, 6 – aggradation in channel facies, 7 – settlements, 8 – shift of villages and land use from zone left for flooding (Starkel 1989; Starkel *et al*., 1998)

Chatterji, 1968). The Dawki fault, causing the Meghalaya plateau still to rise, forms an over 1,200 m high escarpment, where rivers flow over a series of drops, forming waterfalls. The escarpment, apart from waterfalls of smaller streams, is also shaped by huge rock falls and slumps. At a distance from the escarpment, the southern slope of the Meghalaya plateau is dissected by shallow valleys. However, some of the valleys, through which larger amount of water is transported, are incised even hundreds of meters deep into the plateau, where relief is diversified depending on bedrock resistance (Photo 26–30).

Exploitation of limestone, coal, and scant iron ores caused the fragments of plateau near the border to cut apart by open-cast mining. Farther, in the plateau centre, rock materials and weathered rock covers, especially granite are excavated. An almost complete deforestation makes the Cherrapunji region similar to a semi-desert-steppe, which contrasts with a rich canopy of tropical forest, covering steep slopes of canyons. I was really impressed by those contrasts, when I visited Cherrapunji for three days in January 1969 in company of the botanists from the Botanical Survey of India as well as of Dr. M. K. Bandyopadhyay, the then Assistant Geographer of the University of Gauhati.

My dream was to come back here again. Unfortunately, when we did our research in the Himalayas in 1980s, visiting Assam and neighbouring states were forbidden. In 1991 I made contact with Prof. D. C. Goswami of the University of Gauhati — the prominent expert of the Brahmaputra valley. Together with Wojciech, we were waiting long for a right of entry from Delhi. Unexpectedly, we received a positive response after the personal intervention of Prof. Goswami with the state authorities. The Ministry of Home Affairs issued the permission. It stated —"Prof. Leszek Starkel and Dr. Wojciech Froehlich are permitted visit Guwahati (Assam) for the study purpose under INSA-PAS Exchange Programme via shortest route for a period of five days".

For five days we were hospitably welcomed, but always under police supervision. We both gave lectures in hall filled up with over a hundred students. Not only did we visit the historic temples and the edge of granitic Meghalaya plateau with thick weathering cover and landslide sites, but we also saw the immense Brahmaputra with its branches and abandoned channels. Wojciech sampled sediments to examine Cs^{137} contents and later he determined an accretion rate for past decades. The natives had a real amusement watching two foreigners escorted by the police. In the ferry on the Brahmaputra river they may have wondered why the two were not handcuffed!

Finally in 1996, Wojciech Froehlich, Roman Soja and I, managed to reach Cherrapunji and start collaborating with the Department of Geography of the North Eastern Hill University (NEHU). I remember my two colleagues were taken aback when after driving along the road winding up and down through the jungle and arable fields, they suddenly found themselves in a landscape almost resembling semi-deserts — that was formed by man. Since that time on, our Krakow team has been visiting this region every year.

Rainfall regime of Cherrapunji region

The southern slope of the Meghalaya plateau is exposed to the southern winds, which are bringing moisture from the Indian Ocean. The annual rainfall on the Bengal plain does not exceed 2,500 mm and reaches only about 3,000 mm at the watershed of the Meghalaya plateau. But in the mid-slope part at the elevation of about 1,250 m above SL in Cherrapunji and Mawsynram, the annual value fluctuates between 8,000 and 24,000

Photo 1. Sunrise at the Kanchenjunga

Photo 2. Alluvial fan of the Pagli at the edge of the Himalaya with Kurga-Jhara landslide in the background

Photo 3. Earth- and debris flow in the Little Rangit valley (October 1968)

Photo 4. Shallow sliding and piping in Bannockburn (October 1968)

Photo 5. Earth- and debris flow in upper catchment of the Balasan valley

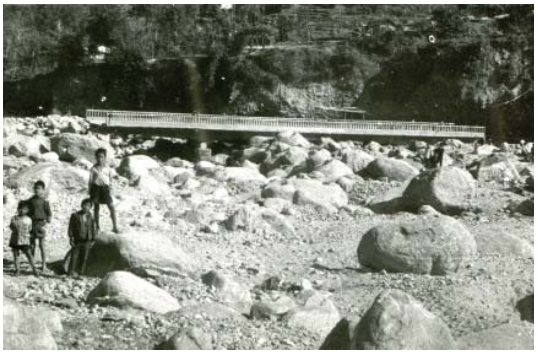

Photo 6. Aggradation of 10 m at the Pool-Bazar bridge (October 1968)

Photo 7. Debris flow in Poobong (October 1968)

Photo 8. Debris flow on re-vegetated slopes in Poobong 20 years later (1998)

Photo 9. Debris flow at Jungpana (7 July 1998)

Photo 10. Upper part of the Ambootia landslide, still active in 1989

Photo 11. Lower part of the Ambootia landslide valley

Photo 12. Middle part of the Ambootia landslide, re-vegetated in 2003

Photo 13. Junction of the Tista and Great Rangit rivers

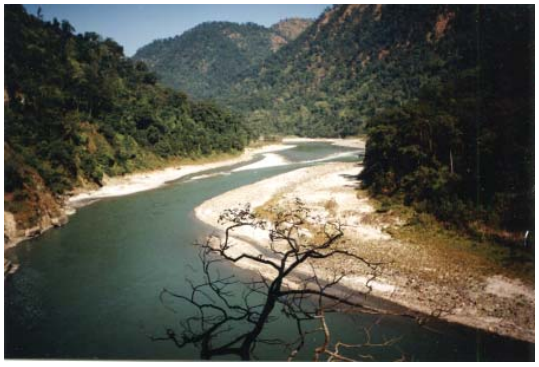

Photo 14. The Tista in montane lower meandering course (1998)

Photo 15. Breaking of the Tista bridge at Tista Bazar in 1968

Photo 16. Growth of young forest on 15 m high terrace of the Tista river since 1968 (photo of 2006)

Photo 17. The Pagli and Sukti rivers aggrading at the Himalayan foreland

Photo 18. Upper portion of the Rehti river fan penetrating into the mountains

Photo 19. Aggradation of the Chel river bed following subsidence in the piedmont, where a new bridge is constructed

Photo 20. Effect of extreme rain, which flooded Phuntsholing town at the Bhutanese border

Photo 21. Meandering river fed by springs downstream of the great fans

Photo 22. Antecedent part of the Kurti river passing through a rising block in the Piedmont

Photo 23. Channel of the Buri Torsa, abandoned by the Torsa before 1930

mm. Rainfall concentrates in five summer months. The monthly precipitation reaches 5,000 mm, and weekly sums are up to 2,000 mm. During a spring season, local downpours of 200–500 mm day^{-1} may also happen. Winter months are totally dry. During several years Roman Soja installed pluviographs over a distance of few kilometres from the basic meteorological station (Photo 31). That was meant to examine the rainfall gradient from Cherrapunji upslope to downslope.

The rainfall distribution during the day and night hours has its characteristic pattern (Fig. 10). The highest precipitation is observed from evening to night, pointing to a convective component. But the intensity above 1 mm min^{-1} at Cherrapunji is relatively rare. Water, in general is running down as overland flow and small creeks are commonly seasonal. The rocky floors, built of horizontally-bedded sandstones are impregnated by iron-rich crusts, which protect the channels against incision and support channels widening (Photo 32). Most of the rivers with rocky steps at the edge of plateau or canyons create magnificent waterfalls during rainy period.

Detailed observations in the Maw-Ki-Syiem catchment

A plateau arm near Cherrapunji, extending from 1,100–1,500 m above SL and hemmed by two canyons, is almost completely deforested, so only tiny patches of forests occur on small steepened parts of slopes. Broad, degraded ground ledges are covered by more or less compact, deep-rooted grass tussocks or bushes that are used as poor

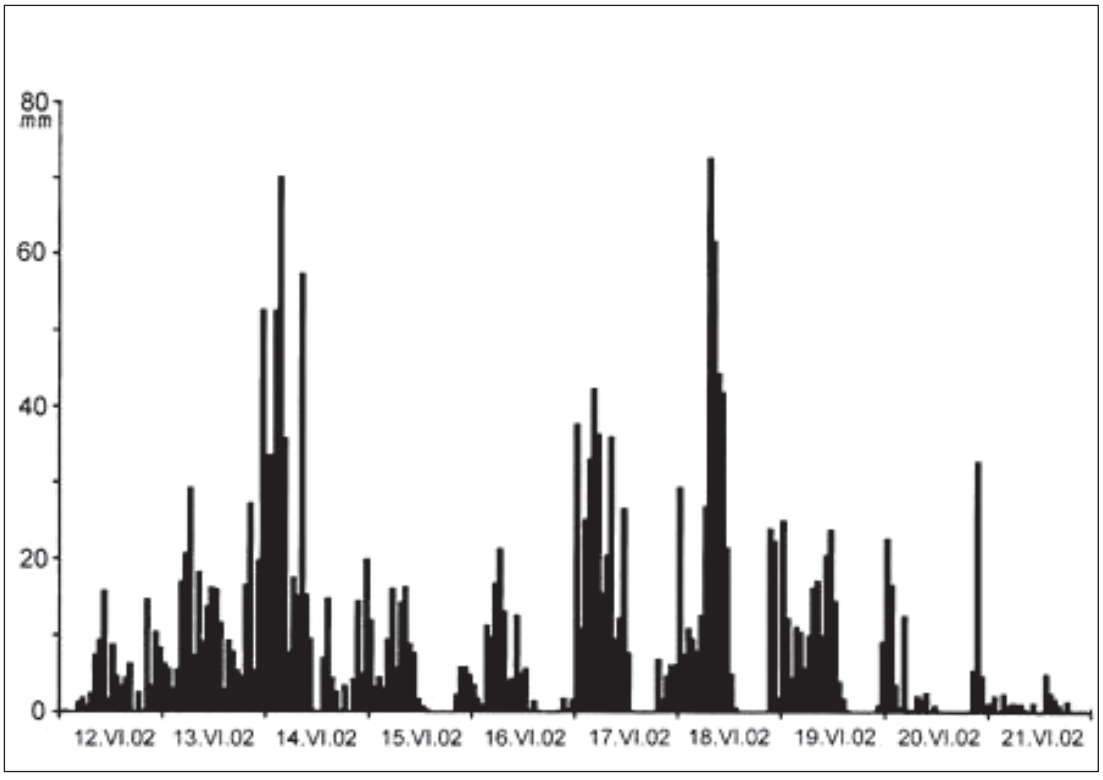

Figure 10. Rainfall intensity per hour during continuous rains of 12th–21st June 2002 in Cherrapunji (after Soja *et al*., 2014)

pastures for sheep or goat. Some fragments of the slopes are bare rocks bearing traces of exploitation such as pit-holes, adits (still in use in some cases) or outcrops left behind by prospectors looking for iron ores or coal. Some of the former excavation sites changed into small gulches.

Slope surfaces are usually covered by 10–20 cm deep armoured pavement consisting of gravels fraction with iron crust formed under conditions of water level rising. The crust is a residual of soil erosion and act as a protective shell (Photo 33).

For our landform mapping, soil examination, water level and discharge measurements, we selected the catchment of the little stream of Maw-Ki-Syiem — 22 ha in area. Mrs. C. Sweet, the teacher living nearby, who collaborated with us, recorded the daily water level for three seasons as much as possible (Photo 34), while W. Froehlich, P. Prokop and H. J. Syimlieh and I measured stream discharges from time to time in autumn season (Photo 35). Mrs. C. Sweet recorded the maximum water level of 2 m above 0 m level in dry season, which corresponded to specific runoff of 100 m^3 sec^{-1} from 1 km^2. It had to be caused by local rainfall of high intensity. As the meteorological station, located about 1 km from there, had recorded diurnal precipitation below 5 mm for that day. It points to a very high spatial diversity in precipitation. Our measurements of discharges during low water stages were also only estimates, as the water from the upper parts of the catchment were diverted by four nearby households using pipes.

Measurements of Cs^{137} isotope in soil profiles, carried out by W. Froehlich (2004), showed, that current annual denudation did not exceed 0.1 mm, which was attributed to protective effect of armouring present in the majority of the area.

The studies in the Maw-Ki-Syiem catchment lasted three seasons and stimulated Prof. S. Singh and Dr. H. J. Syimlieh of NEHU to purchase instrumentation and to start regular monitoring, mainly meteorological one, in two other small catchments, one of them located in a direct neighbourhood of the Maw-Ki-Syiem.

History of degradation and creation of new equilibrium of geoecosystems

Degradation of vegetation cover on southern slopes of the Meghalaya Plateau, which led to the current state, has been an open issue until very recently and mainly attributed to deforestation for cultivation purposes. In 2004, on a side of the road from Cherrapunji to Leiduh at the top of alluvia I found abandoned channel clays with fragments of branches and charcoal. The clays were covered with 1.9 m thick deluvia, while on the slope, gravel armouring was seen on top of the loamy layer. The date obtained by ^{14}C method was 1,600 ± 40 years BP. This suggested that forest downcutting lasted at least since the 4th century AD (Starkel, 2014). Slag chunks that evidenced iron smelting were encountered in not so distant locations. Results of the recent palynological studies indicate that open intra-forest glades were already present there 2,500 years BP (Prokop and Bhattacharya, 2011). Deforestation of the weathered granites in the plateau centre led to exposure of the core-stones (Photo 26), while in the valley floors deposition of up to 4 m thick sandy deluvia took place with charcoals dated from the mid 16th to the mid 19th centuries (Prokop, 2010). It evidenced a strong iron smelting culture prior to introduction of British steel. The latter contributed to declining and ceasing of the local industry. Prokop (2007) estimated that annual production of iron in Meghalaya in the first half of the 19th century required downcutting of 135 km^2 of forests needed for charcoal. According to Prokop rather than agriculture, it is indeed smelting on the

southern slopes that stands behind devastation of the natural forests. Apart from that, on the canyon slopes, such forests withstood only as protected sacred groves or on still-forested fault scarps used for lime production (Photo 36). Smelting, that had developed on a larger scale from at least 16th century, is a sufficient reason and stands behind removal of slope covers and formation of protective armouring, partly cemented on the slope surfaces. On the stripped-off slopes only deep-rooted grass and bushes survived. Such conditions protected against progressing erosion (washing out), and supported shallow infiltration and surface runoff. A new equilibrium formed on degraded ecosystems which used to be typical of high altitude zones of humid tropics.

Detail survey in Maw-Ki-Syiem valley and over granitic substratum near Mylliem, helped to reconstruct the evolution of relief connected with degradation of plant cover in last centuries (Fig. 11).

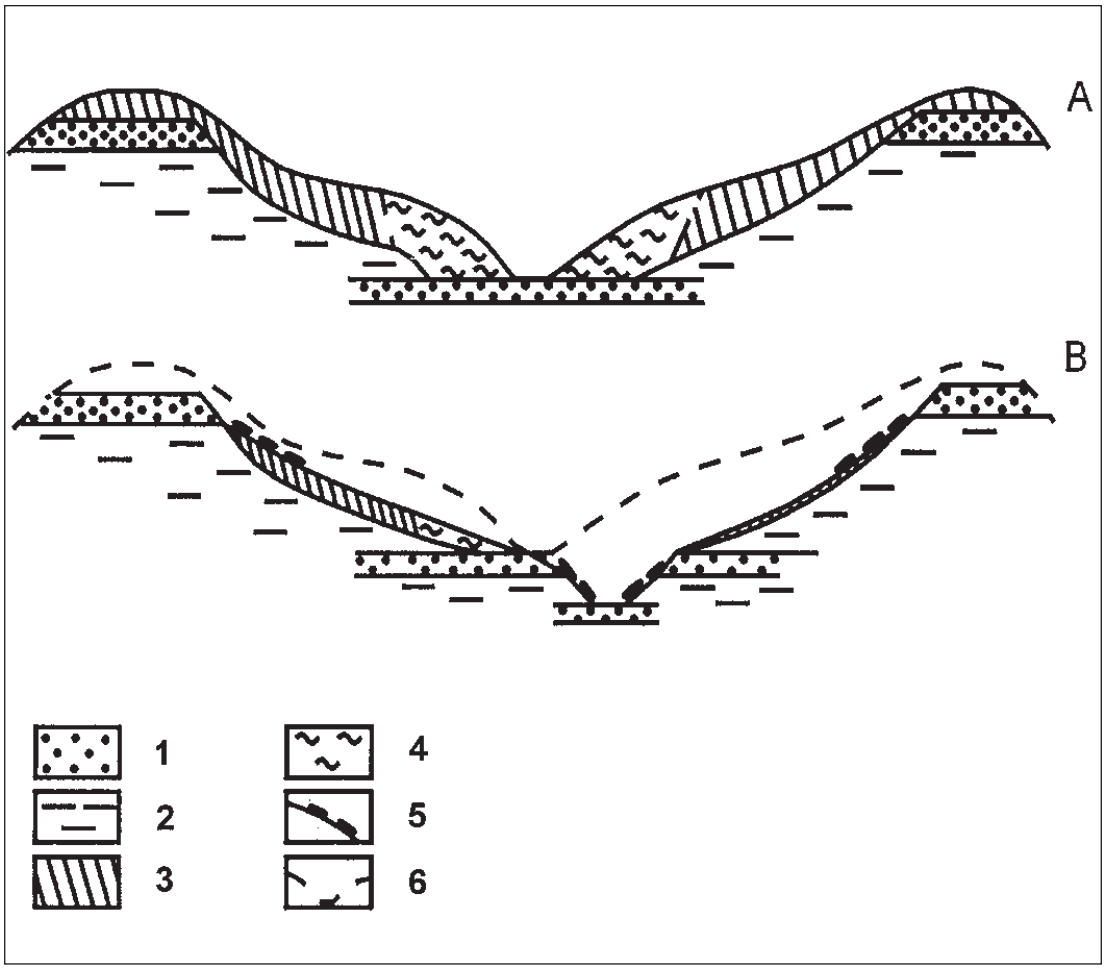

Figure 11. Models of evolution of small river valleys on the southern slope of the Meghalaya Plateau on the sandstone beds at Cherrapunji before deforestation (A) and after deforestation (B) 1 – resistant beds, 2 – less resistant sandsones and shales, 3 – regolith of lateritic type, 4 – colluvial deposits, 5 – sliding sandsone blocks, 6 – former valley cross profile, (after Starkel, 2014)

India: Men and Culture

Meeting with Professor K. N. Kaul

During my first four month visit to India, I travelled stop-by-stop from east to west, from Assam via Calcutta, Ranchi, Varanasi, and in this way I arrived at Lucknow in January 1969. Lucknow is the capital of Uttar Pradesh province, the heart of the most densely populated Gangetic lowland, cultural and educational centre, as well as administrative centre of the past colonial era. The purpose of my short stay in Lucknow was to learn from the achievements of two research institutions located there and to organise my further programme in Rajasthan, at the foothills of Siwalik and in Kashmir. Lucknow was the seat of the GSI Northern Circle, which supervised research in the whole Western Himalayas, as well as of the unique and world-famous the Birbal Sahni Institute of Palaeobotany, where Dr. Gurdip Singh worked and was known to me from the literature. He studied Holocene history of salt lakes in Rajasthan. He made me familiar with the vast Sambhar Lake near the pink city of Jaipur. Both institutions dealt with two domains those were of my particular interest — relief evolution of young mountains and paleogeography of the Holocene. At that time, palaeobotany was the only scientific branch delving and documenting the best climatic and environmental changes in the Holocene. As a matter of fact, in Krakow since my early scientific career, I had been collaborating with palaeobotanists and had learnt to read and interpret pollen diagrams. Just after being introduced to the Institute Directorate, I was told to pay an obligatory visit to the senior Indian botanist — Professor Emeritus K. N. Kaul. It was on a Friday when, after a phone call conversation, the appointment with Prof. Kaul was set for Sunday at 11 am and what is more, the Professor offered to take care of me for the whole day. On that Sunday, I was given a car lift to the house set in a beautiful garden, where Mrs. Kaul awaited me with sophisticated dishes of vegetarian cuisine. Prof. Kaul was a tall, robust, and vigorous man, by no means looking to be in eighties. He, as befits a Brahmin and an activist of the Congress Party, was dressed in a white dhoti.

The conversation started with Prof. Kaul questioning me on my research interests and reasons of coming to India. After this 'examination', he said that his programme for the afternoon was over and that we were to go to the botanical garden. Then, he acquainted me with his life-story and activities. Professor, like his close friend Jawaharlal Nehru, was also from Kashmir. They both fought for independence of India and both were imprisoned. Prof. Kaul offered me the autobiography booklet in which he presented vicissitudes of his youth.

Later, we discussed palaeogeographic ideas, which turned out to be his passion as well. So, he started the journey into the past till the period of Last Glaciation — the journey that was enriched with quotations from Rigveda and other sacred Indian texts. Climate was changing, natural history was changing together with plants, animal realm, and man. Prof. Kaul was convinced that tradition and sacred texts had evidenced information not only from several thousand years ago when deserts of Rajasthan were green and cut by water-rich rivers flowing down the Himalayas, including the famous Saraswati, but also that human memory conveyed the information about events from past 20 and 30 thousand years, up to the Palaeolithic period when extreme Climatic changes occurred. As an example, he cited a story about his native Kashmir. According to the story, a paradise was there in the Kashmir basin with gorgeous vegetation, abundance of animals and rivers flowing down the surrounding mountains. Men led wonderful, heavenly life. Out of

the blue, a quarrel within the pantheon of Hindu gods took place. One of the angry gods spelled dark clouds which brought snowfalls lasting months and years. The vegetation retreated, animals passed away, mountains became covered with glaciers instead of vital rivers, and a huge lake had formed in the uppermost part of the Kashmir basin. Many years later, another god, a lord of thunderstorms, brought about warming. It stopped snowing and at the mountain fringe a huge valley formed, by which the Jhelum River drained out the lake. Glaciers started retreating, and so slowly the land re-vegetated, animals and man reappeared. The paradise came back to the Kashmir basin. I listened to the story spellbound. An unknown writer a couple of thousand years ago described events which occurred much earlier. In fact, as demonstrated by geological and other examinations the coolest phase took place 18–20 thousand years ago when glaciers descended to the Kashmir basin, and lacustrine sediments indicated the extent of a huge water body. Flora contained in those deposits pointed to forest-free, cold climate. There is no better evidence for a message passed from generation to generation that the human memory can go back so far into the past.

Sketching out images from the past, Prof. K. N. Kaul talked about present times as well, not neglecting problems of overpopulation, starvation, industrial development and evolution of a human race. What is more, he ran out into the future. When comparing human races, he hold forth that many of them will disappear, like it is in plant or animal realms. A prospect of human race-mixing is an attribute of progress. For evidence, he pointed to beautiful and gifted individuals born in Pacific islands as offspring of white American soldiers and Polynesians.

That was the amazing journey in temporal dimension, both the past and future, the journey in which I participated listening to the words said by the old man of Kashmir.

But it was not the end of this spiritual treat. Late in the evening, we went by a rickshaw to the botanical garden which Prof. Kaul set up many years ago. Yet, not the trees and beautiful flowers focused my attention. Nearby, in a small building, there were a few exhibition chambers dedicated to history of life on the Earth — presentation of plant and animal realms at a background of geologic eras; history of humans, their expansion, and diversification of the tremendous species on the globe. And then, long lasting explanations on how the variations occurred, what was a role of climatic changes and other natural factors. Prof. Kaul – the naturalist and enthusiastic nature lover — found in me the zealous listener.

When leaving the last exhibition chamber I noticed the quotation from the sacred old Persian book on life:

"What is the life over the Earth?
it sleeps in stone
wakes in a plant
moves in an animal
and may be fully realised in the man,
sounding the question of existence…."

Original text:

What is life?
sleepeth in the mineral
waketh in the vegetable
moveth in the animal
thinketh in the human
realiseth itself in the superhuman

Late in the evening I came back to my hotel. The journey across millennia of the Earth's history, revealed in the Professor's story, was realistic not just a fantasy. It was comparable only to Dr. Faustus' journey across paradise gardens. At the same time,

it was an intellectual adventure. Because of that I was unable to fall asleep and I tossed on my bed for long night hours. Next day, it was quite difficult to catch up with the daily routine, to stick with a time scale measured by spin of the Earth!

Blind monk of the Observatory Hill

On the narrow ridge rising 2,100–2,150 m above SL, the town of Darjeeling is located. From the town there is a panoramic view of the surrounding valleys with tea plantations, and Kanchenjunga massif (8,580 m above SL) looms at a distance. This view was extremely appealing to English rummagers, who scampered down the ridges covered with a dense jungle in the 1830s, as they decided to set there a military camp to control a vast area of the Sikkim Himalayas. With time, a market accompanied the camp and then the city emerged to become the summer capital of India (when the viceroy resided in Calcutta) as well as the Indian Himalayan climbing resort.

Not far from the central square there is the tree-covered hill known as the Observatory Hill. In December 1968 I climbed the steep path and countless steps uphill where a Buddha temple was situated. The fact that it was a place of worship heralded a growing number of shrieking monkeys and stretched on strings, flapping in the wind, multi-coloured banners with printed Tibetan mantras (Photo 37).

At the top of the hill there was a small temple with statues of deity's animals guarding the entrance. I took off my shoes and entered the temple. It was dim. When my eyes adjusted to pale sebaceous lights I saw in the corner of the four-sided temple the gilded Buddha statue and the statue of Shiva in next corner. I was confused. What actually was the temple, Buddhist or Hindu? After a while I went outside. I was surrounded by strings of prayer flags. At the square in front of the temple, a no-longer-young Buddhist monk was going to and forth. To dispel my doubts I decided to ask him what exactly the temple was devoted to. Monk rose towards me, his face and sightless eyes. I saw that he was a blind man. After a while he asked where I came from. I listened to his explanations in beautiful English — "If we want to live in harmony and peace in the world why cannot we worship together our ideas of God, the creator of this world?" I was shocked by the depth of his theological expression. We felt close to each other. Then, he came to the nearest, low-hanging chain of flags, began to grope, tore two flags on which the printed prayers were not yet destroyed by the sun and the rain. He folded the flags in four and holding them in both hands he approached me with a request — "Take this, brother, as a souvenir to your homeland". These small flags, one green the other yellow, are like sacred relics and they are my keepsake.

Holy elephant

The god Ganesh, with a head of an elephant, the largest animal still living in the Indian jungle, is the patron of scholars and, what is more, the prominent personage in Hindu mythology. In spite of that, the elephants are commonly used for heavy load transportation and for riding.

During the Indian-Polish symposium in 2006, Prof. Sarkar treated the Polish team to a dawn ride on elephant back in the Jaldapara forest reserve. We were examining back-swamps and abandoned channels of the Torsa River that had been overtaken by the jungle (Photo 52). The elephants frightened away other animals. Only a rhinoceros misbehaved. It hid himself behind bushes but set us the rear part of his body. Likely he was not aware of the delegates from Poland (Photo 53)!

A few years earlier, Wojciech Froehlich and I roved between the Pana and Gabur river channels and across immense alluvial fans overgrown with over 2 m high grass, at the foot of the Bhutan Himalayas. At a certain moment, in a distance of over 20 meters from the road, we noticed a row of heads sticking up among that grass. We stopped our car and rushed through the grass. A circle of children and young women stood on the trampled grass square while a 1.5–2 m long body of a baby elephant was lying between them. The body was encircled with plenty of wild-flower bouquets (Photo 38). The children and women stood in silence honouring the young king of animals. They were saying good-bye to this remarkable brother with whom they co-existed in the rich nature at the foot of the Himalayas. We, remaining silent, stood with them for a long time and we felt a sort of transcendental link with the nature, the nature which we dare to be the rulers.

Hindu festivals

During my visits to India I witnessed many holidays and folk festivals related to the Hindu traditions. Three of them stuck in my memory the most — the Diwali feast, festival of the Goddess Sarasvati and spring festival.

The feast of Diwali is celebrated at the beginning of November (Photo 39). Crowds of young people, handling lights, were singing and dancing. One year I was visiting Ambootia tea plantation. The owner's house was visited by a team of self-taught artists who, in the candle light sang and danced dressed in regional costumes (Photo 40).

Twice, I witnessed the festival of the Goddess Sarasvati celebrated in January. A week earlier, idols moulded from clay were sold at markets. Then, altars and shrines were built for them, while statues were being dressed in colourful robes. The culminations of the festival were the parades with the statues through the streets of the towns and villages. Children, who sang and played the instruments, accompanied the parading adults. The crowds roaming the streets headed towards the closest river, where the ceremony was followed by the sinking of the Goddess's statues.

The spring festival, celebrated at the beginning of March, was attended only by males, both young and mature. A week earlier or so, mineral dyes, packed in jars or bags, were sold everywhere. Then, the dyes were dissolved in water, and the paint-full buckets were poured over each other. I already had baptism through fire during the first stay, when I travelled with C.P. Vohra through the Siwaliks from Chandigarh to Jammu. The windows in the car were open, and the celebrating males poured two buckets of red and green liquid on us. Pants and shirts could not be washed. Another year, in the foreland of the Darjeeling Himalayas, we were stopped by a singing group of young, coloured men holding their hands. They surrounded our car, but luckily we had the windows closed. The paint had been poured out already, but it seemed that they even poured a drink into their throats.

In another visit to Calcutta we passed a group of nearly naked young men trying to wash away the remnants of paint at the water pumps. The following day I had a lecture at the Department of Geography. Almost half of the students and staff had their hair still dyed, often bi-coloured. Apparently, after a week of washing, the hair returned to its natural colour.

Back to the nature – Arunachal Pradesh

I heard something about the state of the Himalayas where people live in houses without chimneys and on piles (Photo 41), and speak a different language in every mountain valley. Arunachal Pradesh is the

state to which one had to get a separate visa from Delhi.

In 2006, Prof. R. C. Joshi appeared at the Polish-Indian geomorphologic symposium in Shillong. He came from a newly-formed Department of Geography at the University in Itanagar, the capital of Arunachal Pradesh. Prof. Joshi invited me and Dr. Paweł Prokop for a four day visit. In the following year, before going to the North Bengal we have been processing the visas and we were to get a ticket for a particular flight to Guwahati, from where we were to fly by a helicopter to Itanagar, and then travel to Shillong for further research. The visas did not come, but promised that they would await us in Guwahati. We obtained them, a little too late, as the helicopter had taken off already. To seize an extra day we started at dawn by a taxi and being driven along the Brahmaputra we headed south to Itanagar. I was awe-struck by evidences of very young tectonics. The plains of the Brahmaputra, just adjacent to steeply-rising folded Quaternary alluvia, were cut across by the Brahmaputra tributaries. The most recent dating of the alluvia indicates that the latest phase of the young tectonic movement took place in the Holocene few thousands of years ago. After our visit to the University we set off for two day fieldtrip to the mountains dissected by a dense network of steeply graded rivers. Abundant forests were cut apart to make room for vast rice or wheat fields on steep slopes — a typical case of shifting (burning) cultivation (Photo 42). Clusters of villages had houses on piles, without chimneys, with bonfire places in the middle of a large room that were to be entered by a ladder.

Families had many children who were difficult to communicate without a guide. I had a feeling that I went back two to three thousand years and perhaps even to the Neolithic! We found accommodation in the administrative centre of the village.

On the following day, we were returning along another valley and entered again a zone of steeply arranged, loosely cemented gravels, dissected by gorges, to suddenly reach a flat plain stretching all the way to the Brahmaputra.

Mother Lee

By the end of 1968, I happened to be in the Darjeeling Himalaya. It was shortly after the catastrophic rainfall. Prior to measuring the damages I sat on a slope and tried to sense by eyes and mind the scale of detriments. In Pul-Bazar the market square was covered with ample rocks and mud that buried close to 200 persons. Late in the evening, as the downpour waned, the Nepalese houses were invaded by mice, snakes, and lizards looking for a hiding place. To my mind came thoughts about tragedies of individuals, families, inhabitants of mountain villages — hundreds of slid houses, hundreds of lost human lives.

Later on, in reports, chronicles, and geologic documentaries, I found that similar events occurred in 1950 and also earlier in 1899. I was able to delve into a catastrophe mystery thanks to a small book, which I received from my Bengali friend Prof. Subashranjan Basu, with whom I stayed overnight at Calcutta outskirts on 8 March 2003.

The 150-page book was published by the Methodist Church of Calcutta and Lee Memorial Mission. According to Subhash's explanations, the book described the landslide event of 1899. It was entitled — *The Darjeeling Disaster: Its Bright Future* with very appealing subtitles: It was the triumph of six Lee children. The book was written by Mrs. Ada Hildegard Jones (1856-1948) coming from Smithton in Western Virginia. The Lees were missionaries of the Methodist Church and arrived in Darjeeling to convert the natives to faith. On the eastern

Photo 24. Branch of the Torsa river crossing the Jaldapara forest

Photo 25. The Brahmaputra before sunset at Guwahati

Photo 26. Corestones formed in the denuded Myliem granite

Photo 27. Broken watershed after earthquake near Cherrapunji

Photo 28. Southern part of the Meghalaya upland dissected by deep canyon

Photo 29. Tectonic scarp with the Nohkalikai waterfalls

Photo 30. River channel in forested canyon, Meghalaya

Photo 31. The famous meteorological station in Cherrapunji

Photo 32. Deforested plain and rocky channel floor, Meghalaya

Photo 33. Armoured gravely layer protecting deep weathered bedrock, Meghalaya

Photo 34. The teacher Catherine Sweet with her son – our helper in measurements of water level

Photo 35. Simple measurements of discharge in Maw-Ki-Syem

Photo 36. Lime production on forested scarp of Meghalaya

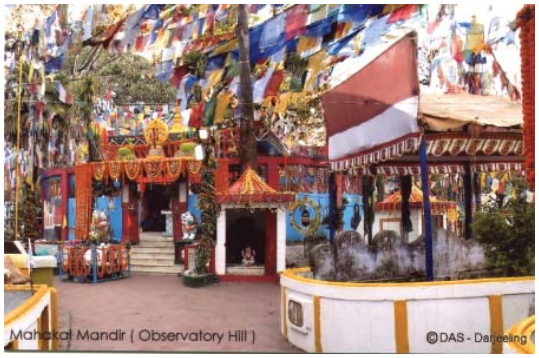

Photo 37. Buddhist temple, 'Mahakal', on Observatory Hill in Darjeeling (photo courtesy Das Studio, Darjeeling)

Photo 38. Dead young elephant lying on floodplain of the Pana creek in 2005

Photo 39. Seasonal temple built for Diwali festival on floodplain

Photo 40. Diwali festival in Ambootia Tea Estate

Photo 41. Village in Arunachal Pradesh

Photo 42. Three-field cultivation system in Arunachal Pradesh

Photo 43. Geography Department students of North Bengal University

slope, where Darjeeling extends, they built a small house called Mall Villa and they lived there with seven children. In September 1899 the couple with the youngest kid set on a trip to congregation in Calcutta, leaving their six other children, aged 5 to 17 under the care of their Bengali maid. On the 24th of September 1899 after the long-lasting rainfall the house started to crack and suddenly slid down the steep slope, burying all its inhabitants. The only survivor was a 13 years old Wilber who lived to see his parents return but unfortunately died eight days later in the hospital. The boy was dying in pain, but insisted on recounting the disastrous event to his mother. At the moment of his son's death, Mrs. Ada Lee experienced a revelation of her five deceased children leading by the hand their brother to heaven.

The letter that the children left behind were written to parents, full of love; they started with the words — "My own sweet darling Mamma, my own dear Papa". The last letter was written by the oldest girl Vida on that fateful morning. She reported: "it is raining heavily; we could not go to Sunday school. At the moment it is an outburst and we hear land sliding. But we are doing fine and send our love…."

On the fifth day after the catastrophe, when the parents finally reached Darjeeling, how did the mother feel? How did she overcome her grief? She lived till she was 92, i.e. 49 years longer than her children. Many years after the catastrophic event, she decided to describe not only the tragic day but also loving and painful memoirs of each of her children. So, in front of a reader one by one the Lee children appeared in their soul and flesh — Vida Maud, aged 17, Lois Gertrude, 13, Wilber David, 13, Herbert Wilson, 11, Ada Eunice 8, and Ester Dennett, 5. The readers learn their faces, hair, interests, loves, enjoyments, plays. Each of the children was equally important for their mother and each deserving the reminiscence. The book was written with a belief that, despite their passing away, they were still alive – in their mother's revelation.

I did not sleep that night – I was reading. Next day, I was leaving Calcutta and my friend Prof. Subhasranjan Basu who had given me that old book on landslides for bedtime reading was asking in the morning whether I slept well at his place!

Christmas Eve

In a chilly morning of 1968 I came down from the uphill located Tourist Lodge, where I stayed, down to the small square at the Planters Club. A jeep from Poobong plantation (one of the most devastated by landslides triggered during the October catastrophic rainfall), was supposed to pick me from there. The jeep was coming late, so there was nothing else to do than to wait and look at the appearing and disappearing of the silver-glistening Kanchenjunga, among the clouds, behaving like a coquettish girl, looking from behind a curtain, curious of an unexpected quest.

At the empty square, near the guard-rail, a not-very-clean car was parked and an elderly, silver-headed, bony man turned towards me. After the overnight stay in the car, he was preparing his breakfast, making the traditional English porridge in his spirit-cooker. The man noticed me and was definitely interested in the presence of another European, dressed in field-trip cloths. He slowly reached me and in his perfect English, asked what I was doing here. After my reply he started to introduce himself. He came from the small Channel Islands, located at the English Channel between France and England. All his family was already gone, except for the only sister who still lived in remote Australia. As a retired person but still robust, he decided to set off in winter for a car trip to his sister.

He travelled across Europe, the Near East and passing through India he decided to make a detour to see Darjeeling known for tea and to bow to the Himalayas. We stood face to face, two aliens who sensed loneliness that day. The first and the only time I was away from home, from motherland at Christmas! It was likely why we both felt surprisingly close. As my driver was coming late, we had an opportunity to chat.

When returning from Poobong at dusk I passed by the Anglican church in which the Christmas carol evening had ended already, the event to which Christians of all denominations were invited. The city of Darjeeling, being the summer resort for Calcutta, was remarkably full of shrines of various faiths, including Christians (Catholics, Anglicans, Presbyterians, Baptists). Nepalese, Sikkimese and Bengalis prevailed in those congregations in 1968.

In my lodge room, to my surprise, I found a ceiling-high Christmas tree! It was the coniferous species imported from Japan — *Cryptomeria Japonica*, spread in the Darjeeling region after cutting down the indigenous jungle in the 19th century. That specimen was unique as it was decorated with silver confetti. Not for nothing two days before the hotel manager inquired with me if I celebrate Christmas!

Like the Englishmen, I felt lonely. Suppressing emotions I sat down to Christmas Eve supper late in the evening, when the first star shone over Krakow already for hours. A Muslim servant, to my will, fried fish for me. A candle and small bunch of flowers were on the table to emphasize the festive mood – it was the servant's invention. Out of my luggage I pulled out a slightly wrinkled wafer (a ritual share of Polish Christmas) and a piece of dry gingerbread (a traditional dish for the day) baked by my Mother. Later on, at the reception lobby, when turning the radio knob I tried to find something familiar – nothing but Indian and Chinese stations. No sounds of Christmas carols. I went out from the lodge. Below, at the foot there were twinkling lights of Darjeeling falling asleep, on the sky the constellation of Orion glistened in the west. And suddenly, from far came to my ears tunes of *Silent Night*….!

I rushed back to the reception lobby, I grasped a young Nepalese and we both hurried down the steep streets where the melody came from. Fifteen minutes later we found ourselves in a small room of a hospitable Nepalese, who treated us with milk tea and mandarins. Next to me, five boys — the oldest handling the old mandolin, the two youngest with raven-black hair, round faces, probably Tibetans, sang real Christmas carols in English, *Holy Night!* I joined the choir. Then, I sang a Polish carol. I chose the simplest melody: *Came running to Bethlehem shepherds!* Truly, I saw a choir of young throats picked up the refrain and a homely musician too.

After two hours I got to the crowded church at Loreto Convent (the same where Mother Teresa worked), and attended the midnight mass celebrated by Bishop Benjamin — a Nepalese. After the midnight mass the colourful crowd filled up the church front yard. Each individual was given a mug of hot coffee served by convent sisters. The bishop mingled with the crowd, and giving the hand wished Merry Christmas to everyone!

When he approached me and exchanged wishes, he asked where I was from. After my reply he asked — what was I, a stranger from a communist country, doing there.

The bishop invited me to his place and showed me rich printed and photographic documentary on the October downpour which was the subject of my study. During that catastrophe, the bishop was one of the organisers of assistance to victims of this disaster.

Collaboration with Indian Organisations and Friends

Collaboration with Indian National Science Academy

Collaboration and scientific exchange between the Institute of the PAS ciences and INSA started in 1984 and has been continuing, although I am not engaged in it personally since 2009 due to my illness. Our collaboration has been focusing on a variety of problems. Since the very beginning, our Department of Geomorphology and Hydrology together with the Department of Geography of NBU carried out studies on present-day geomorphic processes in the Darjeeling Himalaya, which later evolved and expanded to the studies on evolution of fluvial systems in the mountain foreland. Since 1996, the second important problem, supported by the Indian Department of Science and Technology was initiated. It was the study on runoff and soil erosion in the extreme humid area of the Cherrapunji region. The issues were examined in collaboration with the Department of Geography of NEHU.

Every year, 2–4 persons from Poland used to come for a monthly visit to carry out field studies either jointly with Indian colleagues or separately. INSA covered our main expenditures like transport, accommodation and daily allowance. After every visit and at the end of every year we prepared the reports and contributed to INSA's new publications, all in English. These were the products of our joint or separate studies in India. Among them there were three books published in India. Out of these, one on *Rains, Landslides and Floods in the Darjeeling Himalaya* published by INSA, was edited by L. Starkel and S. R. Basu. The second was the proceedings of Indian-Polish Symposium edited by S. Singh. Three other books were published in Poland and many papers were published in international journals. Visits of Indian colleagues in Poland were rather rare and concentrated either on inspecting our field stations or on editorial work. The administrative director of INSA, Mr. Sahni, and officers of India's Department of Science and Technology (DST) had very positive opinion on our bilateral collaboration, which gave rise to organisation of a scientific symposium on environmental changes and geomorphic hazards in Shillong in 2006. About 40 participants from both sides attended the meeting. Polish authors contributed to the memorial volume dedicated to Prof. S. R. Basu, while three Indian authors published in the felicitation volume devoted to L. Starkel.

In the last years the bilateral collaboration has been extending to other research centres in India. Prof. V. S. Kale invited me and Dr. P. Prokop to write chapters in a monograph named *Landscapes of India* published by Springer.

Collaboration with North Bengal University

Our collaboration with the Geography Department of NBU started in 1984 and has been lasting until now. It is bound by a contract between the PAS and the INSA under which an agreement was concluded between the Institute of Geography and Spatial Organisation, PAS, and the NBU. The contractors of the agreement on the Polish side is the Department of Geomorphology and Hydrology of Mountains and Uplands in Krakow (now the Department of Geoenvironment), and on the Indian side it is the Department of Geography, NBU.

The inspiration to establish this long-lasting cooperation was my studies taken after the disastrous rainfall of autumn 1968, that were calling for both thoroughgoing and extended examination. The collaboration was supervised by me until the end of 2009, while the Indian part was supervised by Prof. S. R.

Basu for about 10 years, and then, after his moving to Calcutta, by Prof. Subir Sarkar. For more than a decade the leading theme was examination of gravitational and fluvial processes in the Darjeeling Himalayas, and then the research concentrated on evolution of fluvial systems at the Himalayan foreland. Until 2000, our team and our Indian colleagues, being in continual contact, examined separate study sites. The team of Prof. S. R. Basu focused on studying gravitational processes along transportation routes and in towns, while the Polish team examined fluvial and slope processes mainly in the areas occupied by tea plantations. NBU secured us accommodation in the University Guest House and means of transport, while the Darjeeling Planters Association provided us with the essential rainfall data.

During the annual visits of the Polish team for a month, we presented the results of research, and delivered lectures for students (Photo 43). The study results were published in Polish, Indian and international periodicals. In 2000, INSA published the monograph entitled *Rains, Landslides and Floods in the Darjeeling Himalayas*. The contributors of the monograph included L. Ghatowar, S. Lama, S. Sarkar, and S. Patel of the Indian team as well as W. Froehlich, E. Gil, J. Kasza and R. Soja of the Polish team. The results of the common research were presented later by Prof. Basu at the International Landslide Symposium in 2004 (described separately).

At the turn of the century, the research efforts began to gravitate towards the Himalayan foreland, where continuous forest complexes predominate over tea plantation. The distance of the field area from the campus of NBU also increased, as it was now in another administrative division (Jalpaiguri). The studies focused mainly on alluvial fans of rivers which often change their channels after floods occurring almost every year. The field expeditions with Prof. Sarkar and his assistants used hospitable accommodation of the Forest Service as well as ample data from the network of rainfall gauging stations in tea plantations (Photo 44). The first stage of research was concluded in 2008 with a volume of Polish geographic papers entitled *Present-day Evolution of the Sikkimese-Bhutanese Himalayan Piedmont.* The volume was written commonly by: L. Starkel, S. Sarkar, R. Soja, and P. Prokop. At present, the studies coordinated by P. Prokop, concentrate on problems related to land use management and changes.

My Friend - Subhashranjan Basu

Subhashranjan Basu moved to the newly-formed NBU in 1977, located at the foot of the Himalayas, and there, as a Professor he chaired the Department of Geography for 13 years (Photo 45). He dealt with landform analysis with a particular focus on landslide processes in the Himalayas as well as of alluvial fans at the mountain foreland. I, together with my team, started systematic investigation of landslides and river valleys in the Darjeeling Himalayas in 1984. For twelve years of our academic collaboration we exchanged ideas, especially as we shared varied yet similar fields of interest.

Prof. Basu and his students concentrated on landslides that had formed along road cuttings, or due to deforestation, or exploitation of raw materials (as in the catchments of the Lish and Gish streams) or those triggered in relation to construction works in the growing Darjeeling city.

In 1991, for the first time, we jointly presented the results of our studies during the field trip preceding the symposium of the IGU Commission — Geographical Monitoring and Forecasting. At the beginning of the 1990s we decided to prepare cooperatively the monograph entitled *Rains, Landslides and Floods in the Darjeeling Himalayas*,

which was published by INSA, the mentor of our Polish-Indian scientific collaboration and exchange. It was issued in 2000 and apart from the editors, four Polish, and four Indian researchers were the contributing authors.

In 1990 Prof. Basu joined University of Calcutta, but we kept collaborating and even after publishing of the book, we met several times. I was invited for delivering lectures in Calcutta. In 2004, Prof. Basu, as the Chairman and his disciple Dr. Sunil Kumar De, as the Convenor of the International Association of Geomorphologists (IAG/AIG) Symposium on Landslide in Sikkim and Darjeeling Himalayas, asked me to guide jointly the three day trip to the Darjeeling and Sikkim regions. Prof. Basu and Dr. De jointly submitted the paper to the volume of Geographia Polonica dedicated to commemorate 50 years of my scientific research.

In recent years, Prof. Basu's health became a challenge and he was unable to participate in workshops of Polish geomorphologists in India or in Polish-Indian symposium in 2006. The day before the workshop began, Subashranjan Basu, travelling through the night from Calcutta, arrived in NBU to see me and bid me goodbye. Since then, we were in contact only through correspondence.

In 2007, from the University of Calcutta, I received for reviewing the impressive monograph *Landslides in the Darjeeling-Sikkim Himalayas*. The monograph summarised his long-years of study and pointed out future research tasks aiming at sustainable development in the mountains threatened by landslides. Based on this monograph, the University of Calcutta granted Prof. Basu the title of Doctor of Literature (D.Litt.) — the equivalent to doctor *Honoris Causa*. After his retirement he kept lecturing at two Universities.

Prof. Basu passed away on 24 August 2010 in his 68th year of life. His legacy comprises 14 books and monographs and 65 scientific papers. He guided 19 doctoral theses. He was one of the leading Indian geographers, co-founder of the Indian Institute of Geomorphologists, a friend of Polish geomorphologists and above all a personal friend.

Ranen Dutta and Darjeeling Planters Association

In 1984, having an outlined program of examining the mechanisms and outcomes of extreme precipitation, I together with Wojciech Froehlich came to Darjeeling for the second time and met a new boss — the secretary-general in the office of Darjeeling Planters Association. He was a short, sturdy, dark-skinned man with sharp penetrating eyes, weighing his every word and with an integral pipe in his mouth. I handed him my publication about the course and consequences of the extreme precipitation in October 1968. The publication was also an outcome of the cooperation that I received from four tea plantations. Expounded on what brings us, we asked for further assistance in performing our studies on landslide and fluvial processes in the area of tea plantations and for providing us with rainfall data. From our end, I promised to share the results of our study and to give advice and assistance in prevention of landslides in the tea gardens. Mr. Dutta extended his cooperation and promised to help. We all selected the study sites and then the managers of plantations received a written order to provide us accommodation, board, and transportation. And so began our two decades of long collaboration and friendship. I have been receiving rainfall data from dozens of plantations, not only the annual and monthly records, but daily data as well and especially those for the days of extreme downpours. Besides the main programme of observations in two or three plantations, we visited other sites

indicated by Mr. Dutta. Among other things, at the request of Mr. Bansal we carried out measurements of the largest active landslide in the Darjeeling Himalayas in the Ambootia plantation which I have observed till 2009. Inspired by Mr. Ranen Dutta and Darjeeling Planters Association the authorities of Gorkha Hill Council held a meeting at which I was the main speaker. As a result of that meeting, they were granted the funds for reconstruction of roads that were damaged by landslides, including those leading to various plantations and Nepalese villages.

Based on the data obtained from the plantations I elaborated various multi-year rainfall distribution maps which revealed huge differences in spatial pattern that was important for yield forecasting and organisation of the works on the plantations. In my more than half a century of activity and contacts with various representatives of the economy, mainly in Poland, I never met with greater mutual understanding and selfless approach to solving the urgent problems and to strengthen the science and practice interface.

In the first decade of this century Mr. Ranen Dutta retired. In November 2008, the association "Save the Hills" organised a symposium devoted to 40 years of torrential rain, landslides and floods in the Darjeeling Himalayas. I delivered the main lecture of the event. Ranen Dutta appeared and enthusiastically greeted me. We embraced warmly like old friends, who together have done a significant piece of work for the good of the community.

Family Sharma

One of the plantations, most seriously damaged by mudflows and landslides during the October rains in the Darjeeling Himalayas was the Bannockburn, located on the steep slopes of the Rangnu valley. Because of that, I visited it in December 1968 and was hosted by Mr. Page and his family, one of two Englishmen who then still maintained the positions of plantation managers.

The name of Bannockburn was given in 1860-1870, probably by a Scottish manager to commemorate the battle fought in the Middle Ages at the so-named village — the only time the Scots defeated the English.

In the 1980s during three seasons in Bannockburn, I together with Wojciech Froehlich and Eugeniusz Gil, carried out detailed measurements of rainfalls, water circulations (infiltration, runoff and washing out), soil properties and fluvial process in addition to mapping. At that time the plantation manager was an Indian — Mr. Sharma who lived with his wife. Their daughter was in a collage in Darjeeling. Mrs. Sharma had a lot of beautiful orchids on their porch. They were extraordinary people who were like a family to us. We relied on them not only for room and board, but also in the evenings we discussed a variety of topics and we often shared jokes! We also supported each other in difficult situations. For example, during the riots steered by the Nepalese demanding autonomy, my colleagues could not move outside the plantation. Mr. Sharma after consulting his wife, allowed us to install an automatic pluviograph for recording rain intensity on the flower-patch in front of their house for two summer seasons, until its steering mechanism went dead, a delegated plantation employee took for us the readings of the pluviograph.

When we were working in a wooded stream bed of the Rangnu almost 700 m downslope, and dusk settled quickly, Mr. Sharma, like a caring father, used to send the jeep, which for facilitating our way back, had to follow a breakneck lane to reach almost the valley bottom. When we came back from the field, Mrs. Sharma used to serve us wonderful tea and a plate of tasty homemade rice cakes.

Once, after completing the measurements in the river channel, before my colleagues had collected our surveying equipment, I wanted to set off for a farther hike across tall grasses. Suddenly, they cried – 'Wait'! I stopped and in a distance of about 15–20 meters, I saw a pair of beautiful black panthers crossing the stream from stone to stone. How essential it is to listen to younger colleagues sometimes! Who knows how that meeting could have ended? After returning to the base Wojtek and Gienek very aptly boasted, "If not for our intervention, we might have lost the boss." Another candid incident happened to Dr. Gienek Gil, incidentally a handsome bachelor, who was taking measurements in the upper sectors of the plantation. In the evening, Mr. Sharma complained that according to the supervisor the tea harvest in one sector on the plantation was meagre because the whole brigade of girls instead of collecting tea leaves into their baskets, gazed only at Dr. Gil! Mr. Sharma was a great manager, so he was directed to restore another declining plantation in Phoobsering. After a few years we visited the Sharmas there. After a great dinner we stopped there overnight. Unfortunately, after a few more years the Sharmas retired and left the mountains forever.

Lal-Koti and the Bansal family — Father and son

It was on a warm November day in 1987 when I was introduced to Mr. Bansal – the father. We were returning from the Lal-Koti of Darjeeling, where we had a meeting with the leader of the Nepalese who succeeded in a fight for some autonomy of this region in the Indian parliament and who was appointed the chairman of the new authorities. After the intervention of the Darjeeling Planters Association (DPA) I, as an expert, was invited to give a lecture to the local authorities on reasons and results of catastrophic landslide and flood events as well as on needed counter measures. The Planters idea was to get financial support for reconstructing access roads to the plantations and employees' villages that have not been repaired since the catastrophic precipitation of 1968. I had some slides which I used to show to the students on NBU campus and I also managed to borrow a slide-projector from the Head Sister of the Loreto College. The lecture in Lal-Koti was attended by the chairman assisted by some policemen and by DPA representatives. I had been lecturing for an hour. Using a straightforward language I spoke about mechanism of landsliding, necessity of putting counter measures for the dangerously damaged winding access routes to plantations and villages. The speech somehow, proved effective. Funds for reconstruction of the roads were granted. In this way DPA took me to their confidence and always treated me like a friend. They invited me twice to attend their annual report meetings. The later visits were accompanied by getting together with the planters families. I met many of them earlier, during my former field studies. The planters were coming with their daughters. Unfortunately at that time, I had been married for many years!

My lecture was also attended by an elderly man — Mr. Bansal-senior who was walking with his cane. He begged and asked for advice and help. He invited me and Wojciech Froehlich to visit the largest active landslide of the region in Ambootia; the head scarp of which was continually retreating since 1968, and had been taking away new areas under settlements and forcing a shift of the road several times (cf. the landslide description). To fulfil Mr. Bansal's request, just after the lecture, we drove down around 30 km to Ambootia and stopped at the steep head scarp. Mr. Bansal-senior showed us the damages and wanted us to start our investigation right

ahead. We tried to explain that surveying equipment and examination programme were needed for that. Indeed, during the next two autumn visits, we mapped the landslide, made the levelling and profiling surveys, performed soil and hydrologic analyses etc.

In Ambootia we felt better than at home. At sharp 6:30 am, room-boy used to knock our bedroom doors and bring bed tea. After a good breakfast, we set off for fieldwork at the landslide area 2 km away. We worked there under the care of an experienced plantation employee who also carried packet lunches for the whole team. We came back at sunset. Once we descended the steep slope down to the Balasan River where we were caught-up for the night. We slept huddled together, as the morning near the river was chilly. We expected wildlife visiting us. Mr. Bansal took care of us as his own family.

In the following years I came there for control visits about 12 times and registered how the landslide had changed. I put down rainfall records. Each time I wrote the report with practical comments and handed out our new publications. I prepared the photo album depicting the changes, showing how vegetation was overgrowing little by little, and how slowly landslide parts were stabilising. Each time after my arrival in NBU campus, located at the mountain foreland, I called someone in Ambootia and in the morning of the agreed day a driver picked me (or two of us) for a couple of days in Ambootia (Photo 46). Once, our hosts invited me to plant a memory tree with my last name close to the landslide (Photo 56). I will keep in my memories the celebration of Diwali — festival of lights — organised by Mr. Bansal-junior in Ambootia (Photo 40). In 2006, after visiting the landslide the Ambootia Plantation representatives invited 15 Polish geomorphologists for a gala lunch (Photo 51).

In December 2009, when I was admitted for two days in a hospital in Darjeeling due to a heart attack, an unexpected guest arrived there. The plantation manager, as soon as he had been informed of my illness, left his duties and set off on a 30 km drive because he became worried about his Polish friend's health. Unfortunately everything nice and beautiful must come to an end. In 2009, just before my sickness, I visited Ambootia for last time. The trees on the landslides have surely grown tall.

Asian International Geosphere-Biosphere Programme (IGBP) Symposium in New Delhi

In 1991 Prof. R. B. Singh, human geographer from Delhi University, at present the vice-president of IGU invited me and my colleague Dr. Wojciech Froehlich to participate in the Asian IGBP symposium on environmental problems that was organised in Delhi. That time several of our papers on the Darjeeling Himalayas were known to international academia. I suggested that we might organise a four-day long pre-symposium fieldtrip in the Darjeeling Himalayas. Because of the distance from Delhi, merely 5 or 6 participants from abroad were registered. Nevertheless the field trip was organised and among various field sites, we presented the Ambootia landslide valley, where we were showing great spatial differences of mass movement in parts of that great landslide which were still very active. That meeting gave us, together with Indian friends an opportunity to present for the first time the role of extreme rainfall in transformation of landscape in the Darjeeling Himalayas. Among the participants, my good friend and an excellent British geomorphologist, – the late John Thornes was also present.

International workshop on landslides in 2004

The International workshop on landslides was

Photo 44. Rainfall data collection centre at Upper Phagu Tea Estate with Prof. S. Sarkar (second from the left)

Photo 45. With Prof. S.R. Basu (on the left) at the guest house of North Bengal University

Photo 46. Visit of Ambootia landslide with the owner of Ambootia Tea Estate, Mr. Bansal junior (second from the left)

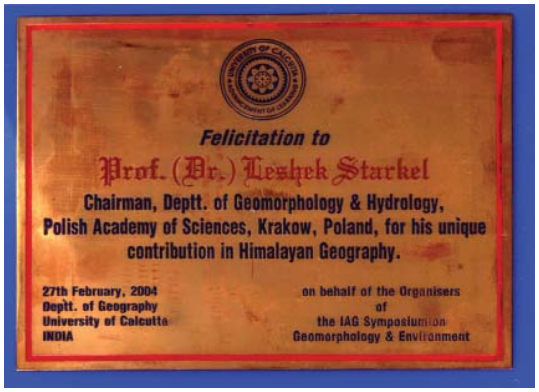

Photo 47. Felicitation to Prof. Starkel presented at Calcutta University in 2004

Photo 48. Discussion on programme of collaboration with NEHU team (from right to left: S. Singh, L. Starkel, W. Froehlich, J. Patkowski, unknown person, H. Syimlieh, P. Prokop

Photo 49. Workshop of project on runoff and soil loss at North Eastern Hill University (18 November 1999)

Photo 50. W. Froehlich and H. Syimlieh – discussion in the field near Cherrapunji

Photo 51. Polish geomorphologists visiting North Bengal University during Indo-Polish Seminar in 2006

Photo 52. Elephant ride at Jaldapara Wildlife Sanctuary during Indo-Polish Seminar in 2006

Photo 53. Rhinoceros welcoming visitors at Jaldapara Sanctuary

Photo 54. Prof. Migoń (on the right) thanking Prof. S. Singh (on the left) for organising the Indo-Polish Seminar during reception at Tripura Castle in Shillong, 2006

Photo 55. Leaders of Polish delegation felicitated with flowers by Indian organisers in Shillong, 2006

Photo 56. L. Starkel planting memorial tree at the edge of the Ambootia landslide valley surveyed by our team

Photo 57. L. Starkel with Mr. Denis, the owner of Cherrapunji Holiday Resort who accommodated our researchers of Meghalaya Upland and participants of Indo-Polish Seminar

Photo 58. Workshop on Landslide Hazard in Darjeeling organised by Save the Hills Association on 21 November 2008

Photo 59. Regional dance performed by students of NEHU during Indo-Polish Seminar, 2006

Photo 60. Grave of Kumbu Singh Gurung, soldier from 8th Gurkha Rifles, buried in November 1943 at Military Cemetery in Krakow, Poland.

Photo 61. The group of Geomorphologists who participated the field session of IAG Symposium on Geomorphology and Environment (2004)

Photo 62. Field session at Darjeeling Himalaya for IAG Symposium on Geomorphology and Environment (2004).

Photo 63. Prof. S. R. Basu and Prof. L. Denes felicitating Prof. Starkel at Calcutta University in 2004.

the initiative of Prof. S. R. Basu (Chairman) and Dr. Sunil Kumar De (Convener). The idea was to invite the members of International Association of Geomorphologists to India and to present methods and results of the studies on landslides in monsoonal climate carried out by Indian Geomorphologists from Calcutta University, NBU and other institutions as well as by the team of Krakow branch of the Institute of Geography of the PAS. The workshop was organised from 27 February to 6 March 2004, more than 3 years after publication of the monograph by the INSA, edited by L. Starkel and S. R. Basu that presented the results of 15 years of collaboration. Prof. Basu invited me to be the leader of the field trip across the Darjeeling Himalaya. The workshop was attended by 30–40 participants; among them were scientists from Italy, Croatia, Hungary and many other Asian countries (Photo 62).

The oral session took place in Calcutta, where the Calcutta University and International Association of Geomorphologists awarded me the copper plate with the following inscription (Photo 47 and 61):

> Felicitation to Prof. (Dr.) Leszek Starkel Chairman, Deptt. of Geomorphology & Hydrology, Polish Academy Sciences, Krakow, Poland, for his unique contribution in Himalayan Geography

On 1st March the fieldtrip to the Himalayas started. On the way to Darjeeling, along the roads made for exploitation of thin coal beds at Tindharia, we visited small landslide sites which get reactivated after every heavy rain. Then, we passed the large Paglajhora slump at headwaters of the Mahanadi river that has been creating permanent danger to traffic on the route to Darjeeling. Both localities were continually monitored by the team of Prof. Basu.

The next stop was at the large Ambootia landslide, which was formed during the catastrophic rain of October 1968, and which was studied by me and W. Froehlich. It destroyed half of the village (about 150 homesteads). The participants were interested in the complex mechanism of landslide evolution and the very slow process of its re-vegetation.

In the following morning, the special attraction was to experience a sunrise over Kanchenjunga from the Tiger Hill. It was a unique experience. During the day, we visited Ging Tea Estate with its Tea Research Station and explored shallow landslides. On the way to Sikkim, we stopped at the broken Anderson bridge over the Tista river. In Sikkim, in the surrounding areas of Gangtok, guided by state geologists, we visited active landslides. The capital of Sikkim has been developing very fast as a tourist centre, but it has limited space for new constructions. During the workshop we had plenty of discussions about protection against frequent landslide disasters (Photo 62 and 63).

Collaboration with North Eastern Hill University in Shillong

After our exploratory trip in 1996 the agreement on mutual cooperation between the Institute of Geography, PAS and NEHU was signed in 1998. This agreement, referring to runoff and soil erosion in the extreme humid area of Cherrapunji region, Meghalaya plateau, was established through a framework of international collaboration between the Polish Committee of Scientific Research and Indian Department of Science and Technology. In this agreement with the contractor from the Polish part was our Department of Geomorphology and Hydrology, Institute of Geography, PAS in Krakow, while from the Indian part it was the Department of Geography, NEHU. The supervision of this collaboration was done

by me and Prof. Surendra Singh until the end of 2009. The interdisciplinary studies were intended to learn processes of water circulation, soil degradation, and relief transformation under extreme weather conditions. For that purpose the records of precipitation (recorded in several intentionally set recording stations), water discharge, infiltration and soil erosion (Cs^{137} method) were collected. In addition to the Polish research team led by W. Froehlich, P. Prokop, and R. Soja, continuous measurements were taken by Dr. H. J. Syiemlieh, and occasionally by Mrs. C. Sweet, the local teacher. We collaborated with the local meteorological station, geologic survey, schools, and Mr. M. West from local environmental protection society. In the following years the Indian colleagues of NEHU established their own hydro-meteorological station near Cherrapunji.

Prof. S. Singh organised several meetings with representatives of various state institutions in 1992, and then the workshop on runoff and soil loss in Cherrapunji (1999), as well as the workshop on mountain resources management (2002), in which representative of the Polish team participated (Photo 48–50). In 2004, the volume with the first results of the research was published. The study results were also presented at the Indian-Polish Geomorphological Symposium in 2006. Problems of degradation of the environment in the Cherrapunji region were addressed thoroughly in the dissertation of P. Prokop, who continues his research in this field.

Indian-Polish Geomorphology Symposium in 2006

The idea of organising a meeting of Indian and Polish geomorphologists came to my mind and I nurtured it for at least 10 years! I wanted to share with the academic world the results of our collaborative study with the Department of Geography, NEHU, as well as with NBU and Calcutta University, covering the Cherrapunji region, the Darjeeling Himalayas and their foreland. This idea was accepted and supported by Professors Surendra Singh of NEHU and Subir Sarkar of NBU. The symposium had been organised by Indian geomorphologists represented by Prof. Singh in collaboration with Association of Polish Geomorphologists chaired by Prof. P. Migoń. The symposium was entitled "Environmental Changes and Geomorphic Hazards". It was sponsored by the DST, INSA, Ministry of Environment and Forest as well PAS.

The symposium was attended by 15 persons from the Polish part, which included representatives from the universities at Poznań (4), Wrocław (2), Łódz (2) and the rest from Krakow, Lublin, Sosnowiec, Warsaw and Rseszów. From the Indian part, apart from the organising team, scientists of 10 universities and research institutions attended the Symposium. The symposium programme included a wide range of activities.

(i) Pre-symposium field trip across the Darjeeling Himalayas (14 to 16 November 2006), which was guided by Professors S. Sarkar and myself. Before the trip, the Vice Chancellor of NBU and I chaired the scientific session, meant as an introduction to the terrain to be visited. Darjeeling Planters Association and Forest Department of Jalpaiguri district were co-organisers of the trip as well.

Initially, the itinerary was devoted to the landslides that threaten roads, like that of Paglajhora and the largest landslide in Ambootia. In Ambootia, the participants visited a tea factory and were welcomed by the directorate with lunch; while at the tea plantation in Ging they were acquainted with the hydro-meteorological Tea Research Station (Photo 51).

In Darjeeling, besides admiring the sunrise

over the Kanchenjunga, the participants had an opportunity to visit the Himalayan Mountaineering Institute with a climbing school, which was attended by the legendary climber Tenzing Norgay (I was fortunate to meet him in 1968). Then, the itinerary led to the Tista valley, where the flood devastated the bridge to Sikkim and finally we came up to Kalimpong to see the wonderful Buddha monastery.

(ii) Visit to the Himalayan foreland (17 to 18 November, 2006.) focused on the geomorphic features and processes shaping the huge alluvial fans which accrete so fast that new and higher bridges are urgently needed. The tea plantations also need to be protected against flooding. This field trip was guided by me, S. Sarkar and P. Prokop. We visited the abandoned channels of the large Torsa river during an attractive trip on elephant back across the jungle, arranged by S. Sarkar (Photo 52, 53). In the evening the participants could listen to songs of the local tribes.

(iii) The journey by bus from the Guwahati airport to the Meghalaya plateau was combined with a brief observation of the huge, intensely braided Brahmaputra river in Guwahati.

(iv) The Indian-Polish Symposium in Shillong on 20 to 22 November. 2006 was held in the new campus of NEHU. Professor S. Singh was the host (Photo 54–55). Over 20 presentations were delivered, mainly dealing with present-day relief-forming processes (including those related to extreme events) in various climatic zones, emphasising on southern Asia and Europe. Vivid discussions followed almost all the presentations. During an artistic entertainment, students, coming from various states of NE India, gave an enchanting performance of dances and folk songs (Photo 59). The banquet at the former Maharja's Palace closed the event.

(v) In the following days the field trip to the southern slopes of the Meghalaya upland was undertaken. The trip aimed to introduce the participants to geomorphic manifestations of active tectonics, canyons with waterfalls, lithologically differentiated landscapes (including karst) as well as a degradation of soils and vegetation which resulted in formation of a semi-desert landscape. The trip was guided by P. Prokop, H. J. Syiemlieh and me. We stayed overnight in Cherrapunji in the picturesque tourist lodge, located at the margin of the tectonic escarpment where we were cordially welcomed by the host (Photo 57). The conference proceedings, published as a monograph entitled *Environmental Changes and Geomorphic Hazards* (eds. S. Singh, H. J. Syiemlieh and L. Starkel) was printed in Delhi.

The Alpinist and the Nepalese

By 2009, for more than two decades, almost every year I embarked to continue my study on effects of extreme rainfalls that was initiated at the end of 1968 in the region of Darjeeling. I always felt there at home and I had many friends there. I keep deep in my heart the view of the Kanchenjunga, shimmering in the colours of the dawn as well as the horrifying picture of 1968 when hundreds of debris flows and landslides mantled and devastated tea plantations, including the tremendous landslide scar of Ambootia.

In the early autumn of 2008, I received a surprising invitation from Colonel Praful Rao, president of the recently formed association for protecting environmental resources and people of the mountains. The association, which took the name "Save the Hills", decided to organise a scientific conference on landslides and similar disasters in mountain regions to commemorate the 40th anniversary of the catastrophic rainfall event of 1968 (Photo 58). The association was aware that I started my research immediately after the

catastrophe and published the results. So I was asked to give an hour-long introductory lecture at that conference. I could not refuse, but I requested the organisers to adjust the conference dates to my November trip to India. Although the catastrophic rainfall event in 1968 started on October 2nd and ended on the morning of October 5th, the organisers agreed to adjust the dates and the conference started on 21st November 2008.

I wondered how to finish my speech so as to draw the audience's attention and to strengthen the ties of mountain people of two distant countries — residents of the Himalayas and my Polish homeland. Suddenly it occurred to me what I discovered a few years ago on the Rakowicki cemetery in Krakow. In the military section of the cemetery at Prandota Street is the headquarter of Commonwealth soldiers, under the care of the British Embassy, where about 200 identical crosses with inscriptions containing the last name of the soldier, the name of the regiment and date of death can be seen. Aloof and alone there are three slabs of two Indian soldiers and one from Cyprus. The inscription on one of them says — Kumba Sing Gurung — of 8th Gurkha Rifles, died in 1943 at the age of 35. It is a typical name of a Nepalese soldier who fought in the squads of Himalayan mountaineers. The soldier died 65 years ago. Before leaving for India in 2008, on All Souls' Day as always, I lighted the candle for the soldier of my second homeland. I checked again his epitaph. It said something more — he died November 21, 1943. Of course, the organisers, after rescheduling the date of the conference on November 21, did not know about it (Photo 60).

The conference was held with the participation of many experts in the field of structural engineering, transportation and geology. The conference sessions took place in the auditorium of the former Loreto College. It was a sunny day. I stood in front of the auditorium. Between the trees, the Kanchenjunga massif, the third highest summit of the world, sparkled. It occurred to me that on the slopes of the sacred mountain in the clefts of the glacier Wanda Rutkiewicz, the best Polish woman climber, rests in her eternal sleep.

And then I knew how to finish my lecture about the catastrophic rainfall of 1968. I said that I dedicated my speech not only to the victims of this incident, but two other people as well. I addressed to the audience — "look at the glowing Kanchenjunga in the ice of which rests the Polish climber Wanda, and in my hometown is your countryman, the soldier Kumba Sing Gurung whose 100 birth anniversary falls this year. Not to mention that our meeting takes place on the 65th anniversary of his passing away". There was a silence. Was it a mere coincidence? Or may be it was something more. I felt a bond with almost a hundred people gathered in the hall. They and I, so far mostly strangers, had become surprisingly close to each other. During the break I spoke with many participants, we had so much to say to each other, like old friends. On the same day I celebrated my little jubilee — the 40th anniversary of my arrival to the second homeland.

Friendship never passes away

My last visit in India was in November 2009. My aim at that time was to select localities and collect samples of alluvial strata, elevated by neo-tectonic movements at the foreland of the Sikkimese-Bhutanese Himalayas for OSL dating. I travelled together with Dr. P. Prokop and an assistant of Prof. Sarkar. Later on, Dr. Prokop proceeded to the Meghalaya plateau, while I headed for a three day study at Ambootia Tea Estate to examine the processes operating over Ambootia landslide valley. The manager of the tea plantation arranged to send me afterwards to Darjeeling from where

I would have been taken to Kalimpong to attend the next landslide workshop scheduled to be held two days later, organised by the "Save the Hills Society". I stopped in the old hotel of Planters Club, where it was possible to dine as well. Unfortunately, in the morning I woke up with a heart-pain, and I could not take a single step. With difficulty I managed to notify a concierge.

A report published in Daily News during my 2009 visit to Darjeeling:

Experts warn of 1968 horror rerun

Our Correspondent

Darjeeling, Nov. 21: In 1968, a torrential rainfall had unleashed about 20,000 landslides, killing thousands and breaching the Darjeeling-Sikkim road at more than 90 places. Forty years down the lane, the chances of a similar calamity loom large.

Experts today warned that this time the devastation would be swifter and more fatal if long term preparedness continued to be ignored.

Leszek Starkel, a professor of Polish Academy of Sciences who has been studying landslides in this part of the country for the past 40 years, said: "I had first come to Darjeeling to study the evolution of mountains in 1968. I was amazed with the destruction. The region had received 1,000 mm of rainfall in 52 hours, which is equivalent to two years of rainfall in Poland".

Speaking on the sidelines of Landslide Hazard Workshop, organised by a group of residents under the banner of Save the Hills, Starkel said there was a possibility of a rerun of such an incident because of the current building boom.

"In the past century, the region had witnessed three extreme periods. There is every chance of those being repeated and this time the devastation would be fatal and would largely be concentrated in the urban areas. There would be chaos if these slides are triggered by earthquakes during rainy seasons. Urging the government to take immediate steps, Starkel said the state should focus on preparing for such calamities.

"Coal quarries in areas like Tindharia must be stopped immediately. Afforestation must be taken up on a war footing and construction (of buildings) on steep slopes must stop," he said.

The pain persisted. The concierge walked me to the adjacent building, where a small hospital, belonging earlier to the Darjeeling Planters Association, was located. I was admitted, examined by X-rays and ECG, and then given medication. The pain was slowly ceasing. Nothing serious was diagnosed. I had a great care. The news were passed to the "Save the Hills Society", where I was supposed to give a presentation during the workshop to be held in two days, as well as to the manager of Ambootia plantation from where I came the previous day. The manager, concerned about my health, arrived in the afternoon to visit me. The next day, stocked with medicines, I came back to the hotel. A day later I gave my presentation in Kalimpong, and after two consecutive days, Prof. Sarkar accompanied me, so I flew to Delhi and then to Poland. I was carrying a heavy baggage full of samples for analyses, yet unaware that I was not allowed lifting weights. Long distance air travel was also not allowed. So trips to India had to be excluded. I cannot appear at the congress of the International Association of Geomorphologists in New Delhi during November, 2017, but my mind will remain there. I will miss my second homeland, their people and specially the warm invitation of Prof. Sunil De.

I wish the Conference a grand success.

Acknowledgement

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Other Indian Research Centers which I visited or contacted in India

1. Geological Survey of India, Kolkata, with branches in Lucknow, Jaipur, and Shillong
2. Meteorological Department, Government of India
3. Central Meteorological Office, Pune
4. Physical Research Laboratory, Ahmadabad
5. Central Arid Zone Research Institute, Jodhpur
6. Soil Conservation Research Demonstration and Training Centre, Dehra Dun
7. Institute of Himalayan Geology, Dehra Dun
8. Birbal Sahni Institute of Palaeobotany, Lucknow
9. National Atlas and Thematic Mapping Organisation, Kolkata
10. Darjeeling Planters Association, Darjeeling

11. Darjeeling Forest Division, Darjeeling
12. National Botanic Gardens, Lucknow
13. Department of Geology and Geophysics, Indian Inst. of Technology, Kharagpur
14. Department of Geology, Kanpur University, Kanpur
15. Save the Hills Association, Kalimpong
16. Bombay Natural History Society, Mumbai
17. Tea Research Association, Darjeeling
18. Department of Geography, Delhi University, Delhi
19. Department of Geography, Calcutta University, Kolkata
20. Department of Geography, Gauhati University, Guwahati
21. Department of Geography, Pune University, Pune
22. Department of Geography, Rajiv Gandhi University, Itanagar
23. Department of Geography, Rajasthan University, Jodhpur
24. Department of Geology, Punjab University, Chandigarh
25. Department of Geography, Ranchi University, Ranchi
26. Banaras Hindu University, Varanasi
27. Botanical Survey of India, Shillong