

Logistics of Flood and Excess Water Control¹

Logistics of flood protection and excess water control management on the state level in Hungary in the mirror of the National Water Strategy

Hungary is located in the catchment area of the Danube River, in a mostly flat area of the Carpathian Basin. Because of this special hydro-geographical condition Hungary has great vulnerability on flood and excess water. Nearly half of Hungary's arable land is prone to inland water inundation which is caused partly by the non-appropriate land use and cultivation technology. The size of flood risk areas is 21,207 km². The length of state managed flood protection dyke sections is 4,157.1 km and 176 km section of dykes is managed by local governments. The number of endangered population is 1.9 million people.

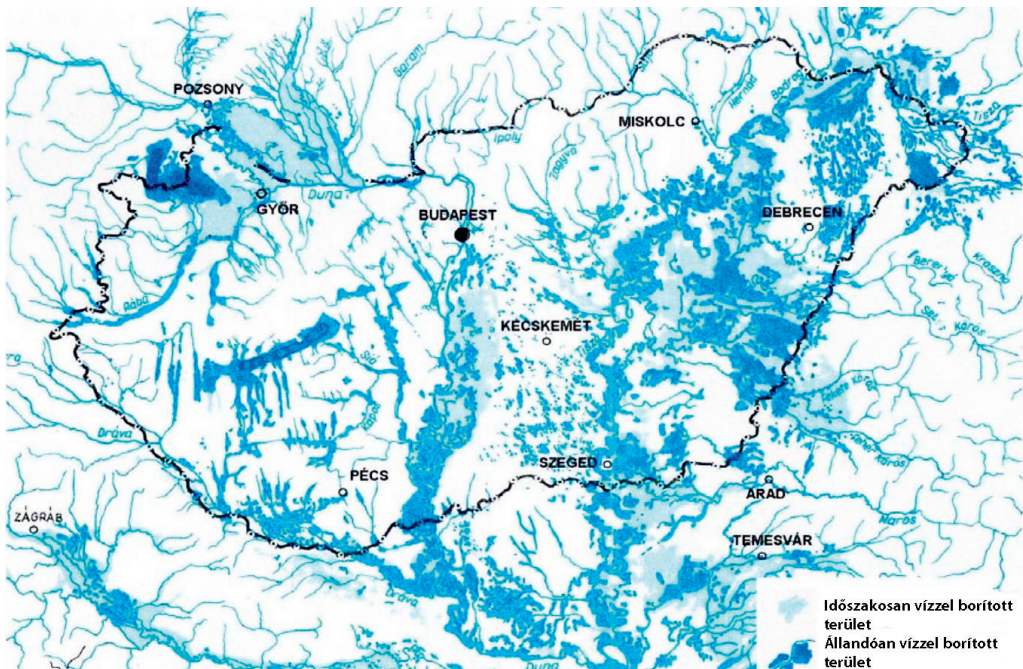


Figure 1. Hydrographic and water management data of Hungary (Adapted from [6a] p. 29)

¹ The text was adapted from the Hungarian courses of the University of Public Service, Baja.

Due to the changes in natural processes and the effects of human interventions, flood risk has increased and as it seems, this tendency will not change in the future. The main reasons of this process are:

- climate change
- the narrow inundation or floodplain areas
- the reduced conveyance capacity caused by the impenetrable barrier of vegetation in the floodplain and by silting up of the floodplains
- deforestation on the upper water catchment area
- the reduced natural flood retention capacity caused by land use
- vague financial background of the maintenance of flood protection structures
- the growth of the value of properties at risk on the floodplain

Institutional background

The Ministry of the Interior, through its Deputy State Secretariat for Public Employment and Water Management is responsible for water management issues and for the direction of the organisations of water management and for water prevention and protection from damages. The General Directorate of Water Management (OVF) carries out the tasks of central operative management.

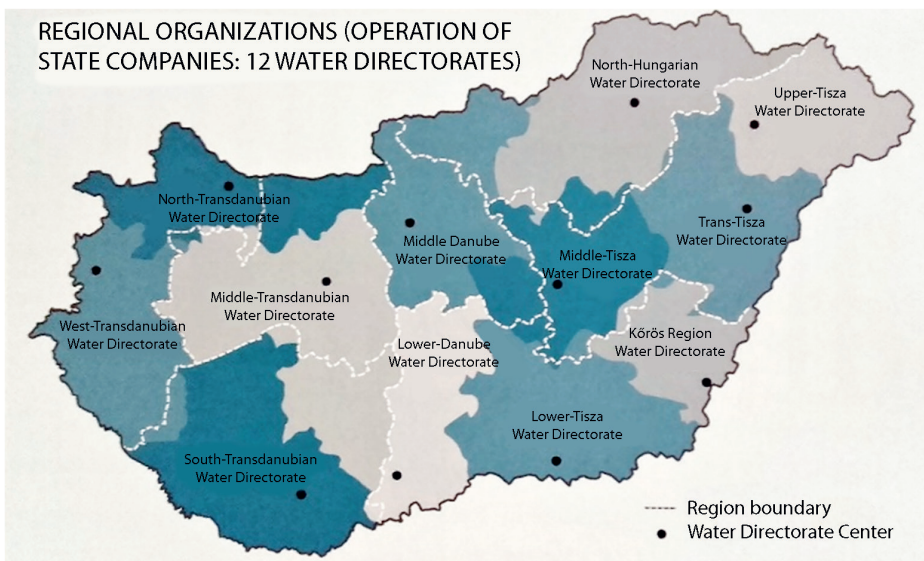


Figure 2. Regional organisations (operation of state companies: 12 Water Directorates) (adapted from [6b] p. 58.)

Areal water management is carried out by 12 water directorates (VIZIG) which are organised according to water catchment areas. The tasks of the directorates include the handling of state owned works including the control of flood and excess water.

12 disaster management directorates have been established, as required by the law, in the counties and in the capital to act as the local authorities of water protection and catastrophe prevention of the country. Some related tasks remained in the auspices of the notary of the local governments. The operational area of the first level authorities of water management and protection mostly coincide with the areas of the water catchment area based water directorates. The second level authority is the National General Directorate for Disaster Management, acting also in the frame of the Ministry of the Interior.

Legal background

The main tasks relating to water management are defined in the following laws:

- Act LVII of 1995 on water management
- Act LIII of 1995 on the general rules of environmental protection
- Act CXLIV of 2009 on water users' associations
- Act CCIX of 2011 on water public utility service

Regulations:

- Decree 10/1997 (VII.17.) of the Ministry of Transport, Communications and Water on flood protection and excess water control
- The EU directives are observed in Hungarian laws such as:
- 2000/60/EC on community action framework on water policy
- 2007/60/EC on the assessment and management of flood risk

The organisation of governmental division of labour in the practice of flood fighting and excess water control

The national management of flood fighting until the extraordinary alert falls within the Minister of Water Management's cognizance, during the extraordinary alert falls within the Government Commissioner's cognizance and in case of especially high hazard (state of emergency) falls within the Governmental Committee's cognizance.

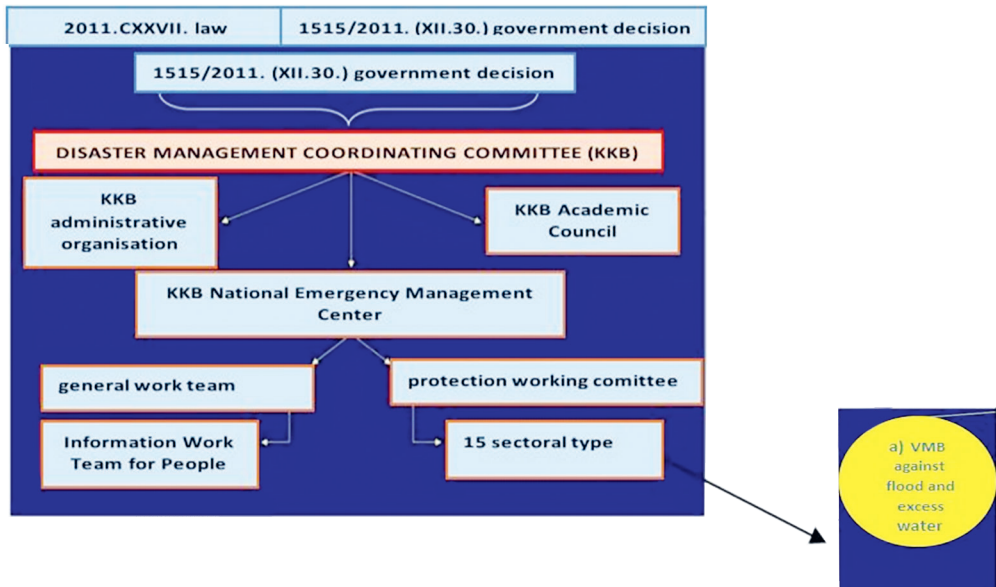


Figure 3. The organisational structure of the Disaster Management Coordinating Committee (KKB) (compiled by the author based on [2])

The Disaster Management Coordinating Committee (KKB) is responsible for the preparation of decisions and the sectoral coordination of tasks related to flood protection. The Government Commissioner's task is the national management of water damage control technical duties in every level of flood warning under the control of the General Technical Managing Committee (OMIT) which consists of staff management, technical duty, technical and supplier professional group, information service.

The OMIT oversees the operation of the defence organisation of the 12 Water Directorates and the capital of Budapest. The local control of flood protection is solved by the Water Directorate's own organisation and by the supply of technical and supplier professional group of the OMIT.

The scope of the OMIT

The following measures fall within the scope of the OMIT's cognizance:

- national management and decision support
- the control of flood protection (Water Directorates, protection staff of the capital of Budapest, local government)
- judgment of emergency
- control in the protection against ice floods



Figure 4. OMIT meeting during the flood in 2013 (adapted from *Vízügy: DUNAI ÁRVÍZ 2013 JÚNIUS videóklip.mp4*)

The duties of the OMIT

The task of the OMIT is to collect and process all information for the managing of flood protection, to compile decision preparatory materials and reports, to publish measures appropriate to decisions, and the monitoring of their implementation.

The OMIT can order the following interventions:

- to prepare flood storage reservoirs (the disposition of its opening and filling), its incidental overflow, sluice (the drainage of water stored in it) taking into account the operating rules of the given reservoir or reservoir system
- opening and closing of levees
- building of localisation lines not included in the localisation plan
- the continuation of protection against threatening phenomena like serious malfunction, levee breach or inundation in critical situation
- the limitation of major drainage structures' function (pumping, water inlet to drainage structure, etc.)
- emergency storage of excess surface waters with the opening of drainage canal's levee (spoil bank) or another way
- overfilling of excess water retention reservoir
- make a proposal for traffic limitation order (limitation of shipping, road, railway closure)
- data recording (aerial survey, fixing elevation of water surface, etc.)
- measures that are different from the updated flood protection plans
- measures about forecast and the publication of it in case of great hydrometeorological uncertainty, runoff, propagation situation and/or greatly contradictory forecast based on the proposal of the Hungarian Hydrological Society

- any other, technical matter connected to protection which is performed with full responsibility
- preparation of government decisions connected to protection in form of written drafts
- flow control related to water quality damage prevention

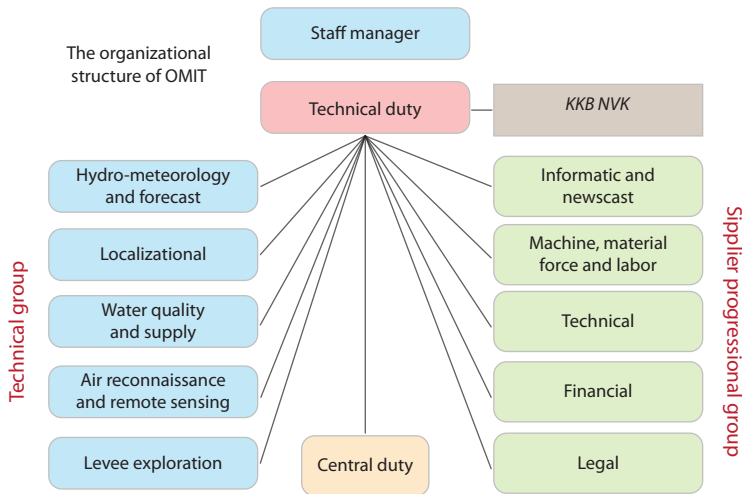


Figure 5. The organisational structure of the OMIT (compiled by the author based on [2])

The OMIT carries out resource coordination on the following aspects or cases:

- using the national set
- using the services of the armed forces and the law enforcement agencies
- alerting the protection squad of the Regional Water Directorates
- protection preparedness can be ordered by the Regional Water Directorates, furthermore by the central and regional municipalities controlled by the Minister
- asking for the services of other Regional Water Directorates depending on the level of emergency and taking into consideration the updated cooperation order
- secondment of technical leaders for protection in local government
- secondment of external experts (universities, colleges, planners, etc.)
- measures related to any other resource which is performed with full responsibility
- permits and oversees of the protection of ice blasting activity
- permits and oversees for alerting and operation of the ice breaker fleet
- the Regional Water Directorates can be alerted and deployed in any part of the country as well as in foreign countries

County organisation of flood fighting and excess water control

In case of extraordinary alert (emergency), the county organisation of flood fighting (Defence Committee) assists the President of the Defence Committee in carrying out the administrative tasks of defence. Performing the tasks of proposal-making and decision-preparation, it participates in the coordination of the protection on regional level and controls the operation of the local flood defence committees.

The Organisation of the Regional Water Directorates in flood fighting and excess water control

The flood fighting is controlled by the Regional Water Directorates at local level in close cooperation with the county organisation of flood fighting (Defence Committee). The 12 Regional Water Directorates have the same organisational structure. As an example, we introduce the organisational structure of the West Transdanubian Water Directorate in the period of flood fighting and excess water control, which is illustrated in Figure 6. The director of the Regional Water Directorate is the head of flood protection who relies on the flood protection staff, the professional groups and the flood protection squad in his/her work.

The duties of the head of flood protection and its assistants

The central head of flood protection is the all-time director of the Regional Water Directorate who controls and leads with personal responsibility the protection works on the operational territory of the Directorate. These protection works are controlled by regulations which are determined in the supplement of the Water Damage Prevention Regulation and it is about the rules of protection against water damages. During alert, the water damage prevention organisation is set up according to the instructions of the director (during flood protection works his position is: central head of flood protection). The leaders of the flood protection organisation and its employees are assigned in the annually published Organisational Assignment of Water Damage Prevention. The central head of flood protection controls the flood protection works through the Flood Protection Staff.

In the absence of the head of flood protection, its assistants proceed with the flood protection works. The assistants must inform the head of flood protection as soon as possible about measures which influence directly the flood protection activity.

Flood Protection Staff

The duties of the Flood Protection Staff is the technical and technological serving of the flood protection activity, the systematisation and analysis of the necessary information, the preparation of the central head of flood protection's decisions, their substantive plan, organisation, the implementation of technical duties and professional service related to flood protection activity. The Protection Organizational Assignment contains the list of the Flood Protection Staff.

Central technical tasks

The task of the leader of the special departments is ensuring the special equipment, means, registrations, data sheets. In case of alert, service is done by the members who belong to the Organizational Assignment of Water Damage Prevention. In case of water damage prevention alert, the members of the central technical duty (head of duty, people on duty, administrators) are subordinated directly to the head of flood protection's assistant who is on duty, and the tasks must be done according to his/her orders. The main tasks of the central duty are determined by the specifications of laws, regulations, directorial orders which are imparted in the water damage prevention regulation. Every important measure with respect to the implementation of protection proceeds from the central technical duty on the orders of the central head of flood protection or its assistant and arrive there also.

The Regional Water Directorate ensures the regional presence through the head of the district flood protection and the dike keepers. Levee guard assistants work under the guidance of dike keepers for the observation of flood phenomena.

General duties of the head of district flood protection

The head of the district flood protection is bound to do every necessary measure for effective flood protection. The head of the district flood protection ensures the performance of the following measures:

- the implementation of every technical measure necessary for drainage of the water without damage and prevention of danger
- constant observation of the condition of protective facilities
- registration of the harmful phenomena
- application and control of the work and equipment necessary for protection
- continuous employment, supply, registration of the attendants in protection
- continuous registration and account of data necessary for the report of protection target, especially of works of the employees in flood protection, and of using equipment required for protection

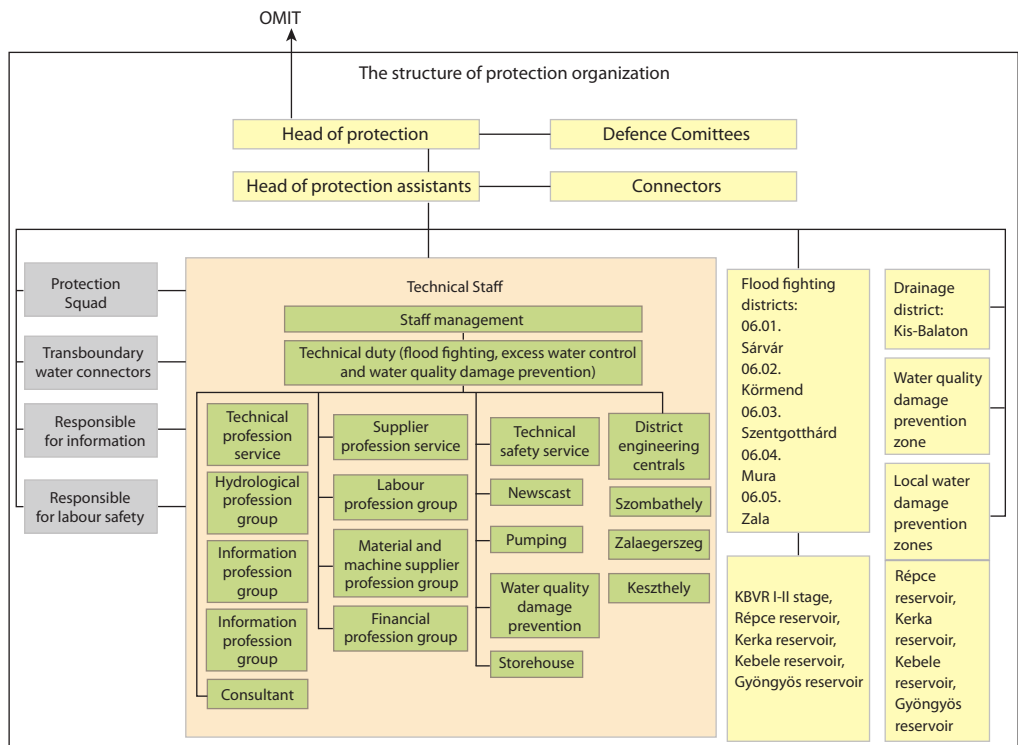


Figure 6. Protection organisational structure of the West Transdanubian Water Directorate (compiled by the author based on [2])

We introduce in a few steps in more detail how this looks in practice. The head of the district flood protection and the technical employees must perform the following tasks:

The construction of the protective facility's district must be marked, in case of heightening the levee its height must also be marked (Figure 7).



Figure 7. In case of heightening the levee, its height must also be marked (photo archive of NYUDUVIZIG)

The dumping grounds must be marked, sandbag filling stations must be established (Figure 8).



Figure 8. The sandbag filling stations (photo archive of NYUDUVIZIG)

The helicopter landing space, mooring of boat, barge possibilities must be marked (Figures 9–10).



Figures 9–10. The helicopter landing space (photo archive of NYUDUVIZIG)

The transport traffic must be organised and controlled; in case the dyke crest is not usable for this purpose, alternative routes must be marked including air and water transport routes.

The continuous material resupply must be organised to the dumping grounds and to the place of construction of the protective facility.

The work of the flood protection teams must be organised and controlled; when needed, headcount reorganisation must be implemented. In case of inadequate headcount, more people shall be requested.

The social conditions (mobile toilet, occasional warmer rooms) have to be ensured for the outside workers.

In case of night work, the illumination of the protection line has to be cared for (Figure 11).



Figure 11. Illumination of the protection line (photo archive of NYUDUVIZIG)

The head of the district flood protection can petition the command of the Directorate Protection Squad in a reasonable case, and he can ask for the help of the Technical Security Service (machine supply, pump installation, in cases of telecommunication and other things). If this measure is insufficient then he can recourse to the help of further organisations according to succession contained in the Resource Requisition Plan.

The protection district can be divided into dike keeper sections, the dike keepers who do their jobs here control the smaller protection works and the building of protective facilities; in case they observe harmful phenomena, they announce the head of the district flood protection who decides about the necessary measures. Levee guard assistants help the job of the dike keepers who work in pairs (one of them on the dyke crest, the other at the protected side of the toe of the dyke) and give reports to the dike keepers in case they observe harmful phenomena. In especially dangerous districts and locations that require continuous observation, the employment of an emergency guard can be reasonable. This emergency guard monitors the dangerous place (e.g. sand boil, leakage, softening, etc.) and gives reports to the dike keepers in case they experience any change.

The flood protection organisation is bound to supply the technical duties of protection preferably with own power (labour, material, equipment, machine and device). The Regional Water Directorate ensures the resources, headcounts for protection by concluding pre-contracts. If the available own power for the supply of the technical duties of protection is not enough then the head of the district flood protection of the Regional Water Directorate takes action about the completion of documents of resources, such as flood protection measures and duties in case of different alert levels.

Duties in case of 1st degree alert

- actualising and synchronising the flood protection plans
- checking the status of the line of protection and the structure
- closure of sluices
- checking/ensuring personal conditions (technical workers, dike keepers, levee guard assistants)
- providing accident prevention education for protectors
- survey, ensuring (requiring) the protection equipment, materials
- checking the operation of news casting, computational systems
- survey of transport and carrying devices, ensuring them if necessary
- checking, ensuring the conditions of the flood protection administration (flood protection diary, attendance sheets, sample contracts, block of delivery notes, etc.)
- preparing the social conditions of protection (accommodation, meal)
- noticing, giving information to the head of the local government connected to protection
- reading the gauges twice a day (at 6 and 18 o'clock)
- making a daily report about the previous day (closing the day at 6 o'clock in the morning), and sending it to the centre of the Water Directorate, then to the OMIT
- supplying the flood protection staff and vehicles with “Flood Protection” signs



Figure 12. “Flood Protection” sign (photo archive of NYUDUVIZIG)

Due to unfavourable weather, pot-holing and ballast of the damaged dyke crest and surrounding roads is necessary, as well as snow clearance of the dyke crests, roads, stowage and de-icing the interlock of the structures.

During the period of 1st degree alert, a 12 hour daytime watch has to be kept. In addition to the dike keepers, an appropriate number of levee guard assistants must be placed (according to the status of the protection line and protection conditions).

Duties in case of 2nd degree alert

- ordering a necessary number of levee guard assistants next to every dike keeper, ensuring emergency guards to structures
- ensuring news casting devices on the newer duty stations (structures)
- ensuring lighting devices (backlight) for night duty
- reading the gauges four times a day (at 6, 12, 18, 24 o'clock)



Figure 13. Discharge measuring (photo archive of NYUDUVIZIG)

- checking the flood protection district, control the work of the dike keepers, levee guard assistants, emergency guards

Signs of flood phenomena:

- white flag – sign of failure
- yellow flag – permanent, intensified observation
- red flag – immediate intervention

During the period of 2nd degree alert, 24 hour non-stop watch has to be kept. In addition to the dike keepers, an appropriate number of levee guard assistants must be placed (according to the status of the protection line and protection conditions).

In the course of carrying out the protection administration, the followings are needed to be done:

- recording the received and given orders and phenomena on the protection line in the protection diary
- carrying out the protection works, registering work time and work performances
- preparing the request of labour, machine and material needs, announcing the flood protection staff of the Water Directorate
- giving information about the expected water stages and the chances of flood protection with regard to protectors (company, local government) who work on summer dikes

- providing information for the head of local governments connected to flood protection
- preparing daily reports and sending them to the flood protection centre of the Water Directorate

Duties in case of 3rd degree alert

Emergency guards have to be ordered to that location of the protection line where a serious threatening phenomenon to stability had formed or this can be expected. The changing of the emergency guards is happening on the spot, the phenomenon cannot remain unattended.

The water stages have to be read, noticed and reported in every 2 hours (in paired hours).

The fixing and ranging of the flood cresting elevation of flood water stages have to be done (usually points fixed per 500–1,000 metres, and with uptaking of typical sections).

All other further work has to be carried out that is typical of lower degrees (organisation, administration, information, control, report etc.).



Figure 14. Controlling the height of the levee (photo archive of NYUDUVIZIG)

During the period of 3rd degree alert, 24 hour non-stop watch has to be kept. In addition to the dike keepers, an appropriate number of levee guard assistants must be placed (according to the status of the protection line and protection conditions).

Duties in case of extraordinary alert

Maximum protection work is needed for the prevention of dike failure!

Duties: as in case of 3rd degree alert.

Gauge reading if necessary (in every 2 hours, when needed, in every hour).

Usually, the needed flood squad and specially equipped profession groups are required from the flood protection staff (like air observation, levee expert profession groups, armed scouts).



Figure 15. Controlling the built protection structure (photo archive of NYUDUVIZIG)

During the period of extraordinary alert, 24 hour non-stop duty is kept not only on the connected Water Directorates. In addition to the dike keepers, levee guard assistants have to be placed (according to the status of the protection line and protection conditions).



Figure 16. Bridge protection during the flood (photo archive of NYUDUVIZIG)

Duties after the termination of alerts

The degrees of alerts have to be terminated in cases when the falling limb had decreased and the discharge of the river returned to normal and a new flood is not expected, therefore the reason of ordering the alert had terminated. The dike failure or implemented cutoff generated on the flood protection levee and on the spot of the damage threatening the stability of the protective facility, a 3rd degree alert cannot be terminated until renovation. Duties which have to be carry out after the termination of alerts are as follows:

- removal of scum, floating debris from the foreshore slopes
- renovation of the damaged protective facilities (foregrounds, slopes, dyke crest)

- collection, repair and storage of the protective materials, devices and equipment
- measures for the replacement of the missing protective materials
- reckoning of protection outputs
- reckoning or return of services, devices, equipment required from other organisations, people
- preparing the summary report (by the head of the district flood protection, or the directorate)

Duties of the urban local governments concerning flood protection and local water damage prevention

In case of flood protection and local water damage events, the duty of the urban local government is the implementation of the rules described in regulations and laws and the supply of public help. The duties of local water damage prevention are the followings:

- prepare for protection
- take part in operational protection
- measures after the termination of protection



Figure 17. Protection practice in Kerkaszentkirály in 2010 with public participation (photo archive of NYUDUVIZIG)

The duties of urban local government outside the period of flood is the implementation of rules described in regulations and laws, the supply of public help, which means the following duties in connection with flood protection:

- preparing a local flood protection plan for mobilisation to ensure resources, etc.
- preparing for protection, among others keeping protection practices

Prepare for protection

The building of drainage facilities: In an ideal case, the drainage system of the settlement is built for the warning level and has water permit of operation.

If the building is not full, it has to strive for the planned, conscious implementation of the surface drainage. It is important that the local government has at least a study plan about facilities which are necessary for the drainage of the warning water mass.

Maintain a defensible state: Regular maintenance of the drainage facilities, mowing at least twice a year (desired twice, ideally three times), and silt removal 3–5 times a year.

Maintenance of pumping stations, machine equipment.

Draining, maintenance of storm storage basin in time.

Repair of facilities, coverings.

The regular and professional revision of facilities has to be done at least once a year (expedient at autumn). Determining failures, measures for their termination.

Operative protection

The management of the flood protection of the settlement is ordered by the mayor and the head of the flood protection appointed by the mayor is responsible for the ongoing works. In view of the protection works, the degree of alert can also be ordered for the settlement according to the flood protection plan of the settlement. This is recommended in favour of the support of the later force majeure certificate.

Measures after the termination of flood protection

The competent Water Directorate must be notified of the termination of flood protection measures.

The protective facilities damaged during protection have to be repaired.

The protective materials, devices and equipment have to be collected and returned to their owners.

A summary report has to be prepared about the protection activities from which a version must be sent for the competent Water Directorate.

Flood protection register plans – Flood control programmes

The flood protection register plans refer to a flood protection district and contain those information that are necessary from a flood protection concept point of view for the judgement of the dike's state. The flood protection register plan contains a technical description and thematically the followings:

- overview and a detailed map of the flood protection district
- a written longitudinal profile section of the flood protection district with drawings
- typical cross-sections marked with the historical dike progress
- flood phenomena observed during earlier floods
- characterisation of the dike state
- soil layer and drilling sections
- listing, location and typical data of the facilities which cross over the dike
- the plans of the crossed facilities

The flood protection plan must be updated once in every year, the technical and personal changes must also be shown. In addition to the flood protection plan, a preparation plan must be made for every flood protection district which has to be updated every year at the beginning of the year. The preparation plan relying on the flood protection plan contains those information which may occur in case of a flood event and which have to be responded to. The preparation plans can be made for typically two scenarios: HWL (Highest Water Level) – peak stage of design flood + 1.0 m. In case of these two water stages the following measures have to be taken:

- the treatment of altitude shortages
- ensuring the levee stability (levee body, slope and subsoil)
- protection against wave action
- ensuring access to roads, routes, logistics
- measures concerning districts requiring special attention

Those parameters contained in the flood protection plans (crest height, dike section size, geomechanical data, etc.), furthermore those districts and works can be determined knowing the above two water stages which have a plan if the given situation occurs. For the creation of a design, the followings have to be planned:

- determining the building technology, specific technical design (e.g. emergency dike, coffer dam, formation of protection against wave action, etc.)
- determining the necessary staff needed for the supply of the protection line's monitoring service and for the building of the protective facility according to the organisational assignment of water damage prevention
- design of human resource needs necessary for the building of the protective facility
- determining the needed machinery for the building of the protective facility
- registration, design of material delivery tools, protective machines
- ensuring the transportation, technical background of loading (supplying routes, etc.)

- determining the material needs necessary for the building of protective facilities, ensuring the material resupply, registration, replacement of protective stock
- registration, design of protective material stocks (materials on both central and protection districts)
- formation of warehouse, storage places

The practical logistical duties of flood protection

The definition of logistics and determining its aim

Logistics consists of material flow and the connected information, value, energy and labour flow. The aim of logistics is that the appropriate quality material gets in the appropriate quantity, from the appropriate place to the appropriate place, with the appropriate way and device, at the appropriate time and with the appropriate cost.

The logistics of flood protection

In flood protection, the speed of countermeasures has a key role. That is why the organisational structure, the decision levels and the logistics of flood protection have to be formed to serve the effective protection. Providing fast countermeasures require not only local knowledge but also excellent organisational skills. The flood protection specialist who knows the places well, has a special flood protecting knowledge, uses the conveyor materials, travel routes, conveyor machines routinely and has an appropriate human knowledge, in other words the well-trained flood protection specialist cannot be ignored in the future when mentioning flood protection. In a lot of cases, the success of flood protection depends on good solutions of the logistic duties. The applied delivery ways and protective materials depend on the opportunities and requirements.

The chain of the delivery of protective materials

In the 19th century, everything was used for flood protection that was available in the proximity of the flood event and was cheap to obtain: straw, floating debris, corn stalk, manure, etc. At the beginning of the 20th century, a significant amount of protective material was placed in the flood protection storehouses because of the weak delivery opportunities. In the last 30–40 years, flood protection ways have changed. The fast delivery of great amounts of protective materials made flood protection possible in a quick and efficient way. Flood protection thus can begin immediately because the most often needed protective materials like sandbag, geotextile, foil, etc. are stored or delivered in greater amounts. Nevertheless, the transport of this large amount of protective material requires developed logistics.

The most important materials and devices of flood protection

The materials of flood protection must be simple, easy to handle and useful in large amounts. Those protective materials and devices enjoy advantage which can be used easily and do not require significant professional skills.

The most important material of flood protection ever is the sandbag. The sandbag can be filled with sand, gravel or clay. Its use depends on the flood protection team. The material of the sandbag is a good quality jute or white plastic bag without UV protection that can be used several times. The emptied bags are washed by the dike keepers, they dry them on the slope and then store them. The used sandbags are not classified as hazardous waste and they are handled accordingly.



Figure 18. The most important material of flood protection is the sandbag (photo archive of NYUDUVIZIG)

The ideal extender of the classic sandbag is the ground-wet muddy sand or fine sand which in its ground-wet state can be formed well and can be easily built upon one another. It is important that the acquisition place of the sandbag's extender have to be searched in "peacetime" and they have to be marked in the flood protection plans.

For the transport of large amounts of filled sandbag and bulk sand or gravel, the application of 1 m³ volume containers is widespread.

The most important device of flood protection is the vane, small machines, generators, lighting equipment, sheet pile machines, etc.

Concerning the materials and devices, there is a three-levelled storage system: national supplies (kept in the available storehouses of the water directorates); the supplies of the Water Directorates (usually kept on the squad yard); and local supplies in the storehouses of the dike keeper's lodge. In case of a flood event, the most often needed protection devices and materials are stored in limited quantity in the flood control storehouses of the Water Directorates. The local supplies are only sufficient to start the flood protection procedure.



Figure 19. Application of 1 m³ volume container bag (photo archive of NYUDUVIZIG)

Transportation, trans-shipment, spoil banking

The protective material can be transported on land (on terrain and/or built road), in the air and water. The building place of the protective material can be approached the best by air; usually, land transport needs the biggest labour demand.

While transporting protective materials, it is important to organise that the drivers carry the cargo to the desired place.

In the chain of the transport of protective materials, trans-shipment places must be inserted to ensure seamless delivery. On the trans-shipment places, transport has to be switched from land to another type of transport; in this case the special problems are the following:

- for water transportation at trans-shipment the available area is usually small
- for air transportation the trans-shipment place can be uploaded practically at night

The chain of the transportation of protective materials has to be set up to match the capacity of the associated delivery points. Only the required spoil banking and reservation should be needed.

Sandbag logistics

It is a long way from the sandpit to the place of building. The first logistic step is the choice of the bagging place (bag charge). Usually, the leader of the local flood protection team can choose from the followings:

- Sandbag filling happens on the place of building; in this case sandbags, sand and vane shall be ensured except for the flood protectors. This can be recommended if the location of protection is easily accessible. In case the surrounding roads are inaccessible, flood protection can start using the devices of the neighbouring levees in a way that it does not damage noticeably the flood protection safety. In many places, sand and spare spoil bank is prepared on the protected side of

the dike but in case of emergency the ramps and the protected side of the crest edge can be exposed to sliding. The vane and the sandbags are transported by the protectors to the location.

- Sandbag filling can happen in the nearest settlement (or if the settlement is out of the way, in a suitable place such as a road junction).
- Sandbag filling can happen in a central filling station. Although the transport route may be long, it still ensures continuous service.

In case of sandbagged protection, in the chain of the transport of protective materials, the filling of the sandbag is important. Sandbags shall be filled to 40–50% of their volume. In order to avoid having to determine how much is in each bag, according to the volume of the bag and the size of the vane it must be determined at the beginning of the work how many vanes should be taken to one bag. Crowded sandbags are useless, with their circled cross-section they are not impervious when placed next to each other because of the gaps between them.

The end point of the transport of protective materials is the building of the sandbags. Usually, sandbags arrive in a single file from the last transport device to the place of building. This is the work that increases the labour demand of flood protection.



Figure 20. Sandbag filling in a central filling station of Győr during the flood in 2013 (photo archive of NYUDUVIZIG)



Figure 21. The single line arrival of sandbags during the flood in 2013 on river Marcal (photo archive of NYUDUVIZIG)

Sandbags arriving at the place of building must be placed. The empty part of the bag shall be folded over and placed to its place joined in a row and column. Sandbags have to be stamped firmly into place to close gaps and create a tight seal. The protective facility made from sandbags will be stable only in this way.



Figure 22. The correctly prepared protection line made of filled sandbags (photo archive of NYUDUVIZIG)

Transportation of protective material

Transport by road

Recently, the protective material transport by vans to the dyke crest has spread increasingly. Vans damage less the unpaved crest and do not break the paved crest; due to the low platform loading and unloading is also faster. Vans can travel in both directions which big trucks cannot perform.



Figure 23. Protective material transport on the dyke (photo archive of NYUDUVIZIG)

At local water damage or migration of eruptive waters, it often occurs that the water washes away on longer or shorter sections the built road, the transport of protective materials and the supply of the population becomes impossible.

Transport on terrain

Since 1999, the protective material transport with military trucks (PTSZ) has proved its excellent applicability. Vehicles travelling on the same route for several days make such mud that these vehicles can get stuck also. The Ural trucks made for heavy terrains performed well at flood protection.

It is a very important step in transport of materials on terrain the delivery of the protection material that arrived at the site to the final place of installation. This place is usually difficult to reach by machine, so the sandbags are placed passing from hand to hand in a chain. In this process a lot of labor force is required and the protection material should be often moved up or down on the embankment slope. With appropriate mechanization, like the conveyor belt, physical work can be replaced. It is simplifying and speeding up the work if the sandbag slides down on the embankment slope on foil or in a plastic half-pipe.



Figure 24. The sandbag slides on foil down the slope (photo archive of NYUDUVIZIG)

Water transportation

Water transportation can reach places that are difficult to access on land. Let us not forget about the crossway transport on the river. From the other bank of the river, protection can be served better and easier with water transportation! Near the intervention – for example at a ramp – a port must be formed at the paved road in favour of the movement of protective materials.

Water transportation has an extraordinary significance, but its effectiveness is really revealed when, due to raining, the crest and the protected side of the toe of the dyke become impassable. Water transportation during flood protection means the following tasks:

- operative activities
- protection from water, savings, construction of insurance
- implementation of transport tasks, like person and device transport, machine and material transport
- observational and control tasks
- removing of floating debris and scum
- other additional and server activities
- closure of dike breaches (sheet piling) works
- rescue tasks

Preparation and logistic tasks during water transportation

Tasks of the preparation period:

- marking of staging and stationing places
- marking of bank connected places – stowage places
- reconnaissance, control of water ways between the main protection line and shipping way
- survey, keeping clean the shipping line
- control of the dike foreground navigability, ensuring the obstacle clearance of the appropriate sizes
- ensuring the watercraft's stationing and logistic supply
- marking of launch and boatyard possibilities
- during a flood protection order – knowing the forecasts
- providing standby service
- implementation of staging to the marked stations
- preparation of material handling and transportation plans

The accident prevention regulations must also be kept during flood on the ships and on watercraft.

Air transportation

The helicopter material transport is a special case of flood protection when land and water transport ways which were applicable for approaching the protection place became impossible.

In precipitated weather circumstances and on leaking aqueous areas, the material transport can be solved by PTSZ, but traces caused by the trucks damage the state of the thin top sheet. For this reason access to the protection line must be limited.

The spread of air transportation made the spread of container bags possible in flood protection, it offered further opportunities for the organisation of large mass stowage and transport. The most important element when organising air transportation is the provision of the appropriate material, length and attachment of the transport rope to the helicopter. The helicopter can transport 2 container bags one-by-one with 0.8–1.0 ton mass.



Figure 25. The helicopter can transport two container bags (photo archive of NYUDUVIZIG)

When placing the container bags, the biggest problem is that the pilot cannot see the area below, so it moves directly with land control on the target area. The rotating bags must be placed under such conditions so that the 2 tonnes do not cause excessive displacement. At the same time, a third person unloads the bags independently of the pilot.

The building of the container bags remains a difficult problem to solve in spite of the fact that the pilots do their jobs as accurately as possible. Several factors make the accurate deposition difficult, for example the two container bags attached to the helicopter rotate along its centre of gravity. It is also a disadvantage that no activity can be performed in the immediate vicinity because of the wind and noise. Furthermore, the building of an accurate alignment cannot be controlled by human operators because the wire rope hanging from the helicopter can hit the person.



Figure 26–27. Placing sandbags by helicopter during the flood in 2013 in Győr (photo archive of NYUDUVIZIG)

During transport by helicopter, the following organisational tasks must be performed in the period of preparation:

- the marking of the basis of container fillings, organising material supply
- the marking of landing and loading places which can be approached by helicopter
- organising land transportation between filling and loading places (transport device, their quantity and transportation routes)
- restoring the carrying ropes

In case of concrete flood protection work it is necessary:

- the choosing of the optimal number of transport helicopters taking into account the material transport requirements and circumstances
- determining the technologic processes of the concrete protection measures (e.g. load, underpinning of slope)
- organising the communication between the place of building and the helicopter

The protective material transport by helicopters has advantages, disadvantages and consequences. It is an undoubted advantage that it does not require a staging area, it can be easily redirected, the practiced pilots place their loads with a 30–40 cm precision, little central bag filling basis is needed, it works independently from every other protective material transport route and little special technical controlling activity is required. Its disadvantage is that no activity can be performed in the immediate vicinity because of the wind and noise. The consequence of protective material transport by helicopter is that the berms are wider and a little bit more irregular.

The building of flood protection roads

The protective facilities made from stone can be classified into two groups according to their functions:

- serving as access road for the inaccessibly compromised districts
- the toed underpinning serving the dike slope failure

The parameters of road building planned from stone are the followings:

- it must be fixed to the toe of the dyke wherever flood protection activity has not yet started (previous protection)
- on the place of flood protection activities it must be tightly built (where slope stability berm is already there)
- the road must be 60–80 cm deep and 5–7 m wide

The stones have to be placed on a geotextile geomesh with back tilting.



Figure 28–29. Flood protection road during the flood in 2013 in Győr (photo archive of NYUDUVIZIG)

The built road must ensure:

- the continuous transport of protective materials
- the draining of water from the dike
- the filtered draining of water from under soil
- if necessary the road can be a solid ground for the increasing of slope stability berm appropriately
- the geotextile has a separator role, the stone is not imprinted into the soft protected side of the surface soil
- the function of the geomesh is weight distribution

The practical logistic tasks of the flood protection squad's staging and application

The task of the flood protection squads

The operation of the protection squads is provided for in the “Special Protection Tasks” section of Decree 10/1997 (VII.17.) of the Ministry of Transport, Communications and Water on flood protection and excess water control:

8. § (1) To carry out protection tasks requiring special preparation and equipment, local protection teams operate at the Water Directorates and regional protection teams at the designated Water Directorates.

(2) The task of the protection squads is in particular to execute:

- a) the temporary closure of dike failure
- b) the temporary closure of the embankment breach
- c) the lighting of workplace
- d) the water transport of protective materials
- e) the installation of temporary pumping platform
- f) water quality damage prevention
- g) diving works

(3) The special protection tasks, the number of personnel and the equipment required for each protection squad are determined by the Minister on the proposal from the Director-General of the Water Directorate.

The involvement of the protection squads in flood protection

The commander of the protection squad is selected by the central head of protection. It is subordinated directly to the central head of protection, in its absence to the central deputy head of protection. According to the rules of the organisation, the members of the squad are under the command of the commander of the protection squad. In the event of an emergency, the squad commander organises the preparation of the team and the purchase of equipment. If necessary he/she organises the accommodation of the squad, the installation and professional tasks in accordance with the order. The squad is subordinated to the head of the district flood protection according to the rules determined in the command instruction. The commander of the squad organises the provision of staff, materials, services and devices necessary for the flood protection tasks. In case of acquisition of special protective materials or devices, he/she helps the work of the supply profession service. If necessary – with special permission – he/she acts on his/her own authority for procurement. The squad commander controls the flood protection activity of the squad and is single-handedly responsible for the team. He/she cares about the compilation of the daily report, the activity of the squad and that the report is forwarded with appropriate timing, format and content towards the central management through the valid data traffic network every day by 7 a.m. He/she implements the instructions of the head of the district flood protection referring to the squad. Before the beginning of the flood protection work, members of the squad must be provided with health and safety training, which must be registered according to rules.



Figure 30. The involvement of flood protection squads (photo archives of TIVIZIG, KÖVIZIG and KÖTIVIZIG)

Excess water control measures in case of different alert levels

The formation of excess water

45% of the area of Hungary is endangered by inland water. The length of drainage canals is 48,513 km, of which irrigation and dual function canals are 4,326 km long. The number of pump stations is 624 of 952 m³/s capacity. During the excess water control, portable pumps can also be installed.



Figure 31. Excess water near the Little Balaton (photo archive of NYUDUVIZIG)

The causes of the formation and development of excess water are due to environmental or anthropogenic factors as listed below.

Environmental factors:

- the unequal territorial distribution of extreme precipitation
- the small surface slope
- soils with poor water-conductivity
- the basin type
- limited gravity guided possibility for drainage caused by high water level of rivers

Anthropogenic factors:

- the change of the ownership of land was not followed by the transformation of the drainage system
- inappropriate land use
- incorrect soil cultivation
- failure to maintain the drainage systems
- the unreasonable filling of the drainage system
- less forests than needed or incorrect tree planting

The content of the excess water control register plans

The defence processes of bodies responsible for excess water control are set out in Act LVII of 1995 on water management and internal instructions of defending organisations. Decree 10/1997 (VII.17.) of the Ministry of Transport, Communications and Water obliges all organisations participating in the excess water control to prepare and update the defence plans, e.g. excess water control register plans.

Types of plans prepared by the Water Directorates:

- general excess water control plans are prepared for the areas of operation of the Directorates
- detailed inland water protection plans are made at the level of protection stages

The Protection Organizational Assignment contains the personal and availability data of participants in the excess water control.

Legislation requires a periodic revision of protective structures and their accessories, protective materials and tools and equipment (autumn review is based on the instructions about the review of the preparation for flood and excess water control).

Tasks in case of different alert levels concerning excess water control

1st degree of excess water control should be ordered if the gravity conditions of the free conveyance of the drainage canals toward the rivers cease to exist or measures should be taken to assure the conveyance of excess waterways.

2nd and 3rd degree of excess water control should be ordered if pump station operation is needed taking into account the water retention in drainage canals or the excess water conveyance regulation.

Extraordinary alert should be ordered if the excess water flooding takes on dimensions that endanger populated areas, industrial sites, main roads, railways and further flooding is expected.

The practical logistical duties of excess water control

The process can be divided into three distinct phases: measures taken in the previous period of excess water control, operative measures during the excess water control and measures after the termination of excess water control.

Measures taken in the previous period of excess water control

Hydrographic observations and data provision (water level, precipitation, temperature)

- observation of water level (drainage canals, recipients)
- detecting and processing rainfall data
- detection and processing ground water data
- detecting and processing temperature data
- controlling the recipients' conditions for retention of excess water (retention basins, oxbow lakes irrigational canals)

Warning to other organisations participating in excess water control

In the knowledge of the data, calling the attention of the concerned Water Management Associations, Municipalities and Defence Committees to the expected excess water status. Sending information to local governments to properly document the expected force majeure events.

Operative measures during excess water control

Ordering the degree of excess water control alert and the interventions needed are regulated in Decree 10/1997 (VII.17.) of the Ministry of Transport, Communications and Water.

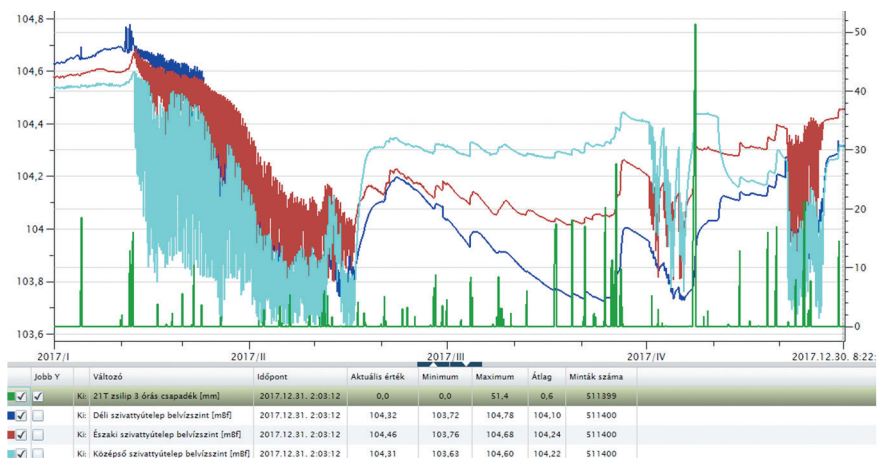


Figure 32. Water level of the pump station on Little Balaton during operation (archive of NYUDUVIZIG)

Mobilising a defence organisation

On the basis of the Protection Organizational Assignment, the number of workers corresponding to the degree of protection is set to work.



Figure 33. Clearing the drainage canal (photo archive of NYUDUVIZIG)

Operation of protective structures

Activities in accordance with the ordered degree are carried out at inland water protection facilities, which are:

Drainage canals and their structures

The drainage canal transfers the collected waters of the excess water system to the main recipient, which is usually a river between dykes. Water is supplied to the recipient by gravitation, pumping or the combination of the two.

Pump stations

Pump stations provide channel water to the recipient if gravity cannot be solved.

Portable pumps

If the capacity of stable pump units is insufficient for drainage, and local pumping interventions are required by installing mobile pump units, this can help flood protection activities.

Measures after the termination of excess water control

After the completion of the excess water control, the protective materials and equipment should be collected and the assessment of their status should be done: damage assessment, maintenance, making accounts, creating the summary report, etc.

**The logistic tasks of the procurement,
installation and operation of the portable pumps**

The logistic tasks of the installation of the mobile pumps

In peacetime, portable pumps are located in flood control storehouses. When ordering the excess water control, the logistic process starts, the steps of which are explained below:

The logistic process can be divided into nine main steps:

1. The process of declaring the level of alert and necessary interventions:
 - ordering the installation
 - assessment of installation sites (determining device, equipment and material requirement)
 - determining the installation method
 - warning – personal announcement
 - providing transportation and loading



Figure 34. Incorrect soil cultivation (photo archive of NYUDUVIZIG)

2. Transport:
 - moving and loading
 - providing a shipping route
 - organising the structure of supply background

- provision of personal care: catering, work safety, social background
 - providing fuel supplies
 - determining delivery schedule
 - quantity and date scheduling
 - structure of a communications chain
 - transport of materials and tools (supplier, loading, personal and installation vehicles, earthwork machines)
3. Starting the installation:
- organising the traffic order of the site – traffic management
 - providing the equipment for the site, landscaping
 - loading, pre-assembling
 - placement and adjustment of pumps
 - installation of piping
 - building a fuel supply system
 - creating illumination
 - performing test runs
4. Operation:
- providing an operational staff with 12 hour shift
 - on-site maintenance of machine-condition repair (crane truck, workshop car, spare pump, etc.)
 - provision of fuel supply according to schedule according to operation data
 - providing lubricants for operation and intermittent oil change
 - management of engine logs, registration of fuel and lubricant use
5. End of operation:
- termination of the reasons for the operation
6. Disassembly ordering:
- providing a shipping route
 - personal insurance of traffic control permits and crossing points
 - ensure the personal and mechanical conditions for assembly
 - management required for assembly
 - availability of transport and loading machines
 - preparing a reception site
7. Beginning of demolition works:
- disconnection of the fuel supply system
 - disassembly and loading of pipelines and pumps
 - other materials and equipment loading
 - delivery to the site
8. Maintenance performing:
- repair and maintenance of pumps
 - maintenance of pipe kits
 - maintenance of fasteners, gaskets, auxiliary materials
 - placement and storage of equipment
 - restoration of pumping site, landscaping

9. Evaluation:

- evaluation of the operation data
- evaluation of the whole process
- modification and refinement of defence plans as needed

Expectations for installation sites

Portable pumps can be installed in a built-in location, on a place that was built in advance but the excess water control should also proceed unhindered when the installation is carried out on an unplanned site. If the site is prepared in advance, less pipe volume will be required and less assembly time and the location could be reached easier. If excess water control is to be started in an unplanned place, it is important to pay attention to the fact that a larger amount of pipe will be needed, so expect a more difficult access because of the roads, weather, etc.



Figure 35. Excess water control without transport possibility on the dike during the flood in 2013 (photo archive of NYUDUVIZIG)

Ensure the possibility of using an off-road vehicle and prepare for the possibility that assembly will be complicated – because of terrain. It will be necessary to ensure access through the pressure pipes, e.g. when crossing on the flood control dikes and fuel supply difficulties may also occur.



Figure 36. Excess water control in an unplanned place in 2013 (photo archive of NYUDUVIZIG)

Case study – Mezőtúr – Temporary flood gate

In the estuary of the Hortobágy-Berettyó, there are three very important facilities for flood protection and excess water control: so-called triple sluice, the flood gate and the temporary portable pump of 12 m³/s capacity. The triple sluice was built in 1899 in the mouth of the Hortobágy-Berettyó. The three-hole structure's board was initially made of wood; after the reconstruction works, it was changed to steel board. Its task is to guide the collected excess water of the Hortobágy-Berettyó to Hármas-Körös and to exclude the flood waves of the river. In 1940–1942, the flood gate was built in the new riverbed at the same time as the Békésszentandrás Dam. On the one hand, the flood gate ensures the conditions for shipping on the distance between Hortobágy-Berettyó and Mezőtúr, on the other hand it excludes the flood waves of Hármas-Körös. The function of the temporary portable pump of 12 m³/s capacity is to pump the water of the Hortobágy-Berettyó into the Körös in the case of the permanently high flood wave of Hármas-Körös. The pumping structure was built in 1993–1994 on the island between the old and the new river section. 24 pump units of 0.5 m³/s capacity can be installed in the pre-formed positions which was also the case during the excess water control in the spring of 2013.



Figure 37. The temporary portable pump during the excess water control in the spring of 2013 (photo archives of TIVIZIG, KÖVIZIG and KÖTIVIZIG)

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