1.2 Building infrastructure

This section describes some public procedures of the government, with cases of Japan as examples. When setting up an observation station in other countries, it is necessary to proceed corresponding each local or national government.

1.2.1 Obtaining permission for land use (example of case in Japan)

Private land

It is difficult to provide a general explanation of the procedures involved in acquiring permissions for land-use for studies that include the construction of towers or roads on private land. It is necessary to discuss the procedures with the land owners, and also, be sincere and patient in all your dealings with them. While proceeding with the procedures for acquiring permission for land use, you should begin the necessary construction and survey work. If the observation site is situated in an area designated as a national park, a protected forest, or an erosion control area, then you need to obtain permission from the proper authorities to use the land. (Details are explained below.)

Agricultural land

When you set up an observation station on an agricultural land, you must first obtain permission from the land owner to use his land for the study. Towers tend to be rather small when built on agricultural lands, compared to these in forest, and the impact of tower and facilities on cultivation should not come to an issue. However, constructing objects such as towers in the middle of fields can adversely affect the efficiency of agricultural work (especially work done by tractors and machinery). When negotiating the rent with the land owner, this point should be taken into consideration.

Although installing a tower in an agricultural field rarely affects the surrounding fields, the consent of neighboring land owners must also be acquired for managing the observation site. The consent can be acquired through a land improvement organization or other local organizations. It is always important to maintain amicable relation with neighboring land owners as they might also provide information that is useful for your study.

Special areas and specially preserved areas in national parks and quasi-national parks

When you set up an observation station in special areas and in specially preserved areas of national parks or quasi-national parks, you need to obtain permission from the proper authorities. For a national park, obtain permission from the Environment Minister; for a quasi-national park, obtain permission from the Prefectural Governor (Articles 13 and 14 of *The National Parks Act*). The installation of facilities is strictly regulated in these areas, and it is therefore, difficult to build a tower larger than the simple one such as shown in Photo 1.1-1.

National and public forests

When the observation tower or roads used to access the research site are part of a national forest, you need to obtain a Permit for Using National Forest for entering the forest. First, visit the local forest management office and forest administrative bureau for applying to obtain permission to use the forest and start negotiating with them sincerely. For land use activities that entail observations to be made as part of a public research project, you can collaborate with public research organizations by following the procedures outlined in the Implementation Guideline for Technical Development of Forest Office and in this case no land use fee will be charged. Instead you will be obliged to submit annual reports on the implementation of technical development. With regard to the use of forests owned by prefectural governments and other municipalities, the process of obtaining permission varies from community to community. Some local governments have systems that allow for land lease and prefectural forest use. Contact the division in charge of forests and follow the necessary procedures. If the target forest is designated as a protected forest or an erosion control area, then you need to acquire a protected forest work permit or an erosion control work permit just as you would have done for the use of private land.

Protected forests

When large-scale construction and other work are to be performed in a protected forest area, you can file a petition for the designation of the protected forest to be cancelled. To apply for such cancellation, either of the following two conditions is required: when no reason can be found for the forest to be designated as a protected area, or; when the outcome of research will be significant in terms of public benefit, and will be more important than the protection of the forest. In reality, however, there is only a slight chance that any such application will be accepted, even if it meets the requirements outlined above. So, when you undertake a small-scale observational study in a protected forest, you need to apply for a permit, register the observation tower and cabin as temporary buildings, and obtain a permit to cut down a few trees (a protected forest work permit).

Erosion control area

The need for observations is not among the reasons for the designation of an erosion control area to be cancelled. It is also virtually impossible to build permanent buildings in a location that is designated as an erosion control area. This also applies to rivers. Building facilities or roads in an area that has been designated as an erosion control area under *The Sand Control Act* or alongside rivers that have been defined as rivers by *The River Act* is extremely difficult. However, it is possible to obtain permission to construct a few temporary buildings in these areas not by obtaining a Construction Permit, but by obtaining an Action Permit in an Erosion Control Area and River.

Tips!

To renovate a boardwalk or an observation station located in a protected forest or in an erosion control area, you must apply for the permits stated above each time. Please remember this when you plan to make large-scale repairs.

Tips 1.2-1

Tips!

Although an observation facility is usually temporary, *The Building Standards Law* requires you to obtain a construction certificate if you intend to use it for a long time period. Besides obtaining land-use permissions, confirm whether you need to obtain a permit for building a tower and an observation house and if required, follow the necessary steps for obtaining these permits.

Tips 1.2-2

1.2.2 Tower construction and maintenance

Height

The specifications of a tower for flux observations between the atmosphere and ecosystem in forests, grasslands, or agricultural lands are determined by the construction budget and on-site conditions however, the tower must be at least higher than the surrounding vegetation. There have been cases (e.g., Laubach *et al.*, 1994) where measurements taken from observation points that were 3 % higher than the surrounding vegetation were not very different from those taken from observation points that were 50 ~ 70 % higher than the surrounding vegetation. Thus, observations are possible at any height provided the observation site is slightly higher than the surrounding vegetation. However, measurements taken at a lower site tend to be influenced more strongly by the surrounding vegetation. So, it is necessary to check whether the observed values are representative of those of the surrounding vegetation. Footprint analysis prior to observation is an efficient means of verification (e.g., Schuepp *et al.*, 1990; Rannik *et al.*, 2000; Kormann and Meixner, 2001; Okada, 2002). However, along with such ex ante analysis, it is recommended that site inspections be performed at various observation heights (depending on on-site conditions). In such cases, the tower must be higher than the surrounding vegetation with a certain allowance. Also, if long-term observations are performed at a height close to the vegetation height, then the vegetation will grow and approach the measurement level. Therefore, when a tower is constructed, its height should at least be 1.5 ~ 2 times that of the surrounding vegetation, regardless of the height of the flux observation equipment.

Tower types and features

In grassland or agricultural areas, a pole-like tower of approximately 3 ~ 5 m is used in most cases

(Photo 1.2-1). There is a free-standing type of tower, which has a pipe driven deep into the ground; a reinforced type that is supported by wires; and a tripod type.

In a forest, a higher tower is needed. Most common type is the one which the observer can climbs up with the instruments. Some of the towers have stairs (Photo 1.2-2; here we call it a “scaffolding tower”) and others have ladders (Photo 1.2-3; here we call it a “ladder tower”). There is also another tower type with an elevating table attached to lift up the instruments to the top.

Photo 1.2-1 A pole-like tower. (Mase paddy flux site)

The advantage of using a scaffolding tower is that it is easy to ensure the safety of the climber. It is also easier to go up and down the stairs when holding an instrument in hand. So the installation and maintenance of instruments is comparatively easy, even when there are few observers.

In case of a scaffolding tower, a four-sided tower is built on a comparatively broad yet shallow foundation, with metal stays that extend outward from the four corners of the tower and are fixed to the buried concrete anchor. An anchor is important for ensuring adequate protection against strong winds, so sometimes a large anchor is buried deep in the ground (e.g., an anchor of more than 1 m^3 is buried at a depth of more than 1 m). In snowy areas, where snow load such as weight on the metal stays and settling force can be significant, a scaffolding tower without stays is possibly chosen. In such cases, it is necessary to have a large base area and to use reinforcing materials that are selected on the basis of their strength to withstand the snow season.

A scaffolding tower that uses ordinary scaffolding pipes and clamps is treated as a temporary construction at a general construction site, whereas a tower used for long-term observation must have an appropriate distribution of stiffened elements, based on specifications such as the tower height, and it should be designed and constructed using strength calculations based on the planned height of the tower and properties of the construction materials. From the perspective of construction and maintenance, using strong, lightweight materials (such as aluminum) is preferable, but the material costs rise steeply.

Many ladder towers consist of triangles (or quadrilaterals) of about 10 cm on one side (Photo 1.2-3). These towers are used for radio and cell phone communications, and materials and strength calculations are often set as standards. Since telecommunication towers are used around the world, it is easy, even in overseas, to construct such a tower as it can be built relatively cheaply according to the local labor costs. It is also possible to add an optional electric or manually operated winch or space for working and evacuation, which is called a safety box or stage. However, this type of tower requires greater physical strength of the observer for moving up and down the tower compared with the scaffolding tower. Also, when working at great heights, the sensation of being high above the ground is more intense, and this will limit the number of people who can work in such an area. It is also difficult to move up and down while holding something, so to set up an instrument you need a pulley and a rope as well as a support person on the ground. A device for preventing falls when working high above the ground or safety gear used for mountain climbing is indispensable for moving up and down this type of tower. Moreover, setting up metal frames that are used for climbing greatly reduces the worker's sense of fear when installing and removing safety appliances. This type of tower stands like a rod on a base, whose area is relatively small with respect to its height. So, when it is used for long-term observations its foundation should be laid very deep in order to prevent it from falling over. Also, it is possible to build this type of tower, depending on the height, as a self-standing tower without the use of stays. However, when the height of the tower greatly exceeds the top of the forest canopy, metal stays and an anchor of appropriate size are required.

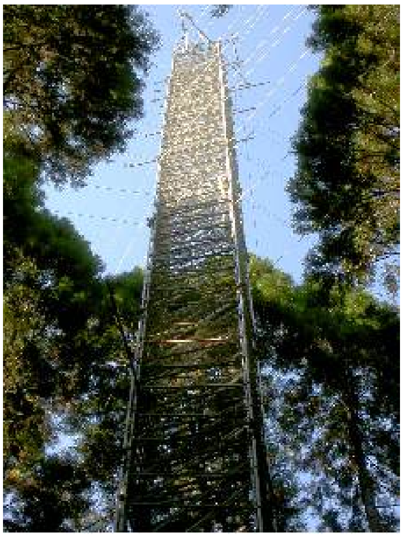

Photo 1.2-2 "Scaffolding tower" with access stairs. (Kahoku Experimental Watershed)

Photo 1.2-3 "Ladder tower" with a ladder-like part for easy access. (Kampong Thom Province, Cambodia. Photograph: courtesy of Shimizu Akira)

Photo 1.2-4 Monorail used for transporting construction materials.
(Yamashiro forest hydrology research site)

Transporting construction materials

Since usually a high tower is constructed in a forest and most of the construction work is done in the mountains, the transport of construction materials is arduous. Use a monorail to effectively transport materials in large amounts while minimizing damage to the forest floor (Photo 1.2-4). The price of a monorail car is about three million yen, and the costs of laying the rail is about 30 ~ 40 thousand yen per meter.

Tower maintenance

Maintenance of an observation tower is essential to ensure that observers working at the tower are safe. If a tower is constructed with a strong foundation, using materials that have been chosen based on suitable calculations of their strength, it can last for more than ten years unless damaged by a natural disaster. However, even when it does not experience strong winds or a severe earthquake, the tension in the stays of a tower will change slightly because of vibrations caused by wind and the observer’s movements on the tower. It is thus preferable to measure the tension of the stays once a year, using a tension meter, and to adjust the tension based on these measurements. It is also necessary to constantly check for corrosion of the metal joints on the tower and to replace them when necessary by ordering the parts from a supplier or by contacting the tower builders.

Especially for a tower built in a forest, even if the tower itself is designed to sustain vibrations induced by strong winds, it is conceivable that a tree could fall on the tower or on the stays and cause severe damage. To prevent this, any tree that could potentially interfere with the tower or the stays should be cut down. In a forest with a fully closed canopy, cutting down a single tree creates a gap in the forest, but the influence on the observational results appear to be small (e.g., Kelliher *et al*., 1995). If many trees need to be felled, there are concerns that labor for cutting and transporting them will be considerable and that the habitat will change. Instead of cutting trees, it is recommended that the target trees be tied to other trees with a steel wire (Photo 1.2-5). Trees that are tied together do not fall as easily as single trees and the risk of their causing damage to the tower or to the stays is also much lower. The Kahoku Experimental Watershed of the Forestry and Forest Products Research Institute was hit twice by typhoons with

Photo 1.2-5 Trees connected by steel wires at the base (left) and at 10 m (right). The red arrows show the connections. (Kahoku Experimental Watershed)

maximum wind velocities of 50 ms^{-1}, but none of the trees that had been tied together fell and so there was no damage to the tower or the stays and the observations can be continued without interruption.

At an observation site located on an agricultural land, agricultural work such as crop planting, harvesting, and cultivation is conducted (mostly by machines) several times in a year. These alter the ground surface conditions. A tower built on an agricultural field can interfere with agricultural work, but observations of upward radiation, soil heat flux, plant community profile, and so on are often carried out in the vicinity of the tower, so it is important to ensure the homogeneity of the land, even in the vicinity of the tower. There are two ways to do this: One is to carry out observations by setting up a simplified tower that can be easily transported (such as a tripod) and pulling down the tower temporarily when there is agricultural work to be done; the other is to carry out observations at the permanently installed tower after asking the field administrator to avoid agricultural work around the tower and having the observers themselves do the agricultural work manually in the vicinity of the tower. Even when the latter option is chosen, it is better to pull down the tower once in several years to ensure cultivation of the entire agricultural field.

1.2.3 Electric power supply

Commercial power supply

Wherever possible, the use of a commercial power supply is recommended as is the introduction of a facility that has considerable capacitance. A back-up power supply should be maintained for the event of power loss, and the observation system should have automatic data saving and power restoration features.

To install a commercial power supply at the newly set-up experimental site, certain steps have to be followed by an electrical contractor who is affiliated with the power company based in each region. For example, Kandenko Co., Ltd in the region around Tokyo. Locally registered electricians can be recruited through the local office of the power company in each region. If there are residential area close to where power is to be installed, setting up the power supply can be done free of charge for a certain distance from such area. When a meteorological observation tower is installed, it is often several kilometers away from the residential area, there will be indispensable expenses for its installation, including the installation of electric poles and electric wires. Rental expenses will accrue when electric poles are present on private land.

Tips!

Comprehensive discussions with personnels of an electrical engineering company affiliated with a power company can greatly improve their support level. It is important to emphasize the public nature of observations, taking the time and making the effort to provide an explanation for your activities and to participate in negotiations on-site prior to beginning your study.

Tips 1.2-3

When installing a power supply line, high voltage electric power lines should be laid as close as possible to the observation tower or to the experimental site in the forest, and a transformer should be set on the nearest electric pole. This avoids problems such as power line noise after the start of the observation, and it also makes it easy to change the capacitance.

As for wiring in a forest, in order to prevent the wire from being cut or damaged by falling trees, the power supply line should be laid on or under the ground after being placed into protective tubes. (Products such as corrugated pipe, accordion pipe, and so on can be used.) If a power supply line is laid under the ground, then maintenance after setup is difficult. It requires efforts such as setting up a linkage box midway along the line. As for wiring on telephone poles, it may be necessary to cut down some trees so that they do not touch wires (Photo 1.2-6). When conservation of the forest is a priority, it is better to install the power supply line on or under the ground. When the situation allows, "unfixed wiring" on the ground, using protective tubes, is favorable for maintenance (Photo 1.2-7).

When the location is isolated and a commercial power supply is unavailable, a dynamo or a power generation system employing solar panels can be used. Nowadays, many observation sites use a photovoltaic generator based on solar panels. When a dynamo is used, it should be installed in such a position that its exhausts do not affect flux observations.

Photo 1.2-6 Aerial wiring in a forest. (Yamashiro forest hydrology research site)

Photo 1.2-7 Unfixed wiring. The forest floor undulates, so it is more practical to use underground corrugated protective tubes for unfixed wiring. (Yamashiro forest hydrology research site)

Tips!

When a high voltage electrical power line cannot be extended to the transformer of the utility pole near the observation facility, long-distance power transmission is needed between the transformer and the observation facility either with an AC 100 V line or with a 200 V single-phase three-wire system. In this case, the resistance of the wire extending to the observation facility can cause a voltage drop. As a result, depending on the electric power required, sufficient power-supply voltage may not be available for conducting observations. Use of a wire with small conductor resistance (i.e., a thick wire) helps to minimize the voltage drop. Many measuring instruments that operate normally at 95 V perform unstably at 90 V though the degree of instability depends on the individual measuring instrument. Therefore, the voltage of the AC power supply that is to be used for the observation system needs to be checked.

Tips 1.2-4

Electric power generated by a photovoltaic power source

Photovoltaic cells on solar panels charge batteries using sunlight. During sunshine hours, a photovoltaic generator generates more power than what the observation system needs, and the surplus is used to charge the battery. The charged power is consumed during the night or during non-sunshine hours. A charge controller is used to prevent the battery from overcharging and also prevents excessive discharge. In terms of the charging capacity and durability of the battery, it is most appropriate to use a deep cycle battery as it can be used even when fully charged, and it also delivers a consistent voltage as it discharge. The capacity of the solar panel and the battery depend on power consumption by the observation system and on the amount of available solar radiation. For more information on how to calculate capacity, please refer to the technical data posted on related websites. The available electric power is limited. The observation system should have low power consumption itself, and equipped with automatic power control functions including saving of on-memory data, turning off low-priority devices for power saving, and restarting of observation.

Photo 1.2-8 A flux observation tower using solar cells. (Tura, Russia)

The main precautions to take when using solar panels are as follows: 1) solar panels should be used so that the wind impact on the flux sensors is minimized; 2) the wind resistance of the panel is high, so care should be taken that the tower or the panel is not blown away by the wind; 3) the electrical resistance of wiring should be small and loss of power should be minimized; and 4) care should be taken to avoid electric shocks caused by the electric current in the panel. Measures such as light shielding should be taken when work is performed in the vicinity of the panels. An example of a flux observation tower using solar cells is shown in Photo 1.2-8.

Tips!

When a lead storage battery becomes overly discharged, the precipitated lead sulfate forms hard crystals on anode of the battery. This is called sulfation, and these crystals have a low solubility, which makes it practically impossible to recharge the battery. Deep-cycle batteries are the same, because they are lead storage batteries in principal. However, their electrode are strengthened to make them more discharge resistant than ordinary lead storage batteries.

Tips 1.2-5

Tips!

Solar panels should be set up to achieve the maximum possible production of electricity. Sun's rays should preferably hit the panels at a right angle, but since the sun's angle changes daily and seasonally, solar panels are usually set at an angle of 10 ~ 40 degrees facing south (north in south hemisphere). The influence of surrounding obstacles on the panels is taken into account as well as the influence of the panels themselves on flux observations.

Tips 1.2-6

1.2.4 Lightning surge countermeasures

Lightning damage on tower observations

Since lightning tends to strike tall, pointed objects, observation towers are prone to lightning strikes. Electric current (lightning surge) generated by lightning momentarily produces a large current and a high voltage, and these can damage observation facilities. There are two kinds of surges: a direct lightning surge caused by direct strikes on a tower; and a lightning-induced surge caused by strikes on the surrounding area. Both cause damage that can include destruction and breakdown of electronic observation equipment. Surges caused by direct lightning strikes generate a particularly large amount of energy and they can cause severe damage, including fires.

For flux observation facilities, installation of lightning protection equipment is required by law when the facility is first established and additional measures can also be taken to ensure the protection and safety of observation equipments. The former includes installing a lightning rod on an observation tower, and the latter includes protecting power lines, communication lines, and sensor signal lines.

Lightning rod

Installing a lightning rod is the most effective protection against direct lightning strikes. An observation tower more than 20 m high is required to have a lightning protection system (lightning rod) according to Article 88 of *The Building Standards Act*. A lightning rod can be installed by the builder during tower construction (Photo 1.2-9) and at the same time a ground with little earth resistance (< 10 Ω) should also be installed (Fig. 1.2-1).

Even if lightning strikes the lightning rod, surge current can be produced by electromagnetic induction in various cables wired to the observation facility and this can damage the observation equipment. Thus, surge arresters are required even if a lightning rod is installed.

Photo 1.2-9 A lightning rod (left) and a ground (right) installed in an observation tower.
(Sapporo forest meteorology research site)

Surge arrester

Abnormal current flow induced by a lightning surge can damage observation equipments by various routes (such as via electric power lines, communication lines, and sensor signal lines). A surge protection device (SPD) or a surge arrester should be installed between the observation equipment and any line that is wired to the observation hut.

Countermeasures for power lines

Lightning-proof transformers or SPDs in power circuits are used as surge protectors for power lines, as shown in Fig. 1.2-1. SPDs in power circuits are smaller and cheaper than lightning-proof transformers; thus, they are easier to install in a temporary facility such as an observation hut. To discharge surge current to the earth

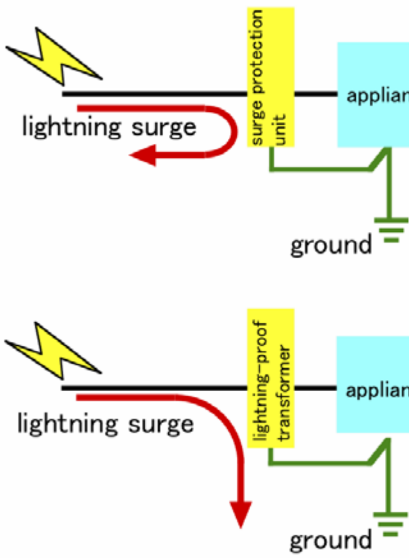

Fig. 1.2-1 Comparison of lightning-proof transformers and SPDs.

through the ground, it is necessary to prepare a good ground that has little earth resistance. Preliminary discussion with builders is necessary as these protective devices should be installed at the same time when the power lines are laid. Plug-in appliances called surge protectors are commercially available, and some of these are built into power strips or uninterruptible power supplies and are easy to use.

Countermeasures for communication lines

For communication lines, SPD is selected according to the type of line used. As with power lines, these are installed during line installation, and plug-in appliances can be used. Damage to the network can be reduced by using optical lines.

Countermeasures for sensor signal lines

Sensor signal lines installed in a tower can also serve as discharge paths for surge current. A large number of measuring instruments are set up in observation towers, so using terminal blocks for these instruments (Photo 1.2-10) makes it easier to perform lightning surge countermeasures. All signal lines should be grounded to protect the observation equipment, with protective elements such as ceramic surge arresters or varisters. The connecting location and the surge path are the same as those for SPD in a power circuit (Fig. 1.2-2). Ceramic arresters are small and well suited for connection to the terminal block. The terminal block should be connected to a ground that has little earth resistance.

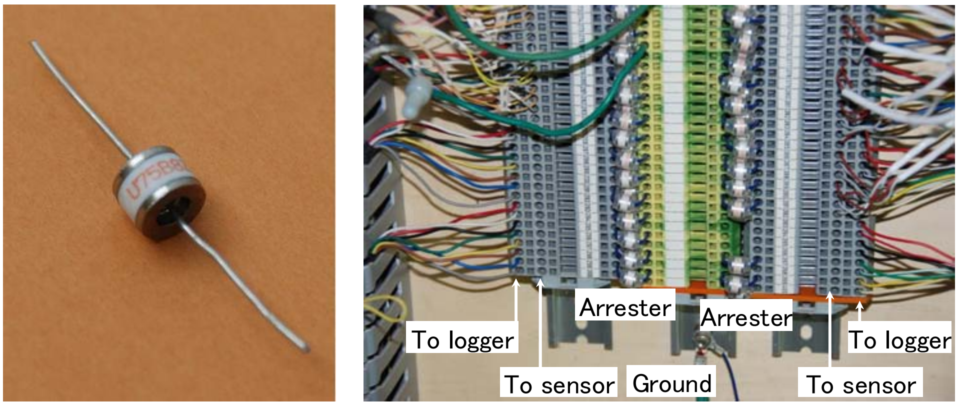

Photo 1.2-10 Ceramic arrester (left) and arresters connecting the terminal block (right).

Installation of the ground bar

A ground bar should be installed as a countermeasure against noise and lightning surges that may damage signal lines and electric power supply. These grounds should be separate from the lightning rod ground (Photo 1.2-9). The ground for electric power supply is installed when the source facility is constructed. As shown in Photo 1.2-10, a ground is needed when countermeasures are taken against surges in signal lines. A ground that is installed for such a purpose should have a ground resistance of 100 Ω or less. In an area of ordinary geology, simply inserting a 50 ~ 100 cm ground bar into the earth (Photo 1.2-11) is enough to keep the resistance within 100 Ω. The ground bar should be inserted into a soil that is as moist as possible, and the tip of the bar should be at a depth of 40cm or more. Argilliferous soil is preferable. Sometimes it is difficult for a ground to work effectively in gravelly soil, in such a situation, ground bars should be buried 2 m apart and wired in parallel. It is also preferable to wire the ground with electrical cables that are as close as possible to the grounds of the connected device.

Photo 1.2-11 Ground bar.

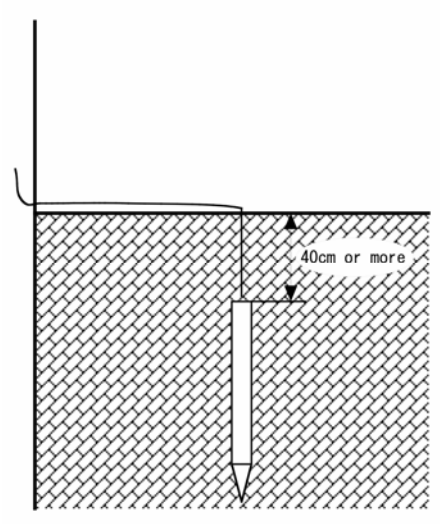

Fig. 1.2-2 Installing the ground bar.

Other matters

The most effective lightning countermeasures are cutting off the equipment power and unplugging the power and communications cables. Instantaneous failure of a power line can occur during a lightning storm, and an operational check of the observation equipment should be performed once it is safe to do so. It is also very important to avoid working at or near a high tower when lightning strikes are likely.

Tips!

Telecommunication appliances, such as telephones, modems, and computers connected to the two types of electric lines (power cables and telecommunications lines) are the items most likely to be damaged by lightning. This is because of electrical surges that enter one line and exit by passing through another such appliances. This can occur in electrical as well as ground lines. Therefore, it is best to avoid addition of unnecessary electrical lines.

Tips 1.2-7

Tips!

There is often little space for connecting protective elements, such as ceramic arresters, to a terminal block. To prevent these elements from touching, they should be protected with heat-shrink tubing or insulating tubing (Photo 1.2-10).

Tips 1.2-8

1.2.5 Observation hut

Flux observations often require an observation hut where computers and data loggers can be stored. The hut should be as small as possible so as not to disturb the observation environment. Building the hut close to the tower will shorten the length of plumbs and wires and will be conducive for operation, but the hut must be placed at a distance that ensures it does not impact the observation environment. A simple heating, ventilating, or air-conditioning facility may be needed, depending on the climatic conditions. It is better for the floor of the hut to be above the ground level. This makes it more difficult for soil and sand to be brought into the hut, and it also makes it easier for you to keep the inside of the hut clean. For a hut used for storing gas cylinders for calibration of CO_2 concentration, it is more convenient to bring the cylinders into the hut when the hut is built near a road. It is also a good idea to set up two huts, one for storing gas cylinders and the other for storing data loggers and other measuring instruments. When the latter hut is close to the tower, it has the advantage of requiring shorter wires.

The Forestry and Forest Products Research Institute uses commercially available tool sheds placed on a concrete foundation (Photo 1.2-12). The floor has to be adequately strong to store heavy items such as gas cylinders. For this reason, concrete or other sturdy materials are used. Steel transportation containers are used as a observation hut in countries where security is poor.

Many of the present observation sites of the Forestry and Forest Products Research Institute have huts just beneath the tower, the reason being that such an installation has little effect on the tower. This is particularly true in Japan, where the forest canopy tends to be dense. In contrast, observations near the ground level in a forest should be performed far from the hut or tower. When an observation hut is set up on an agricultural land, on grassland, or in an open forest with little vegetation, it needs to be far from the tower. When minimal amounts of data are to be collected, it may be possible to avoid installing a hut at all in which case data loggers, control loggers, control equipment, and measuring instruments can each be stored in separate measuring boxes.

Photo 1.2-12 An observation hut close to the tower (center), and a shed for gas cylinders (right). (Sapporo forest meteorology research site)

Photo 1.2-13 A measuring box with desiccant (closet dehumidifier) inside.

Tips!

Measurement boxes should be sealed as tightly as possible to keep out rain, insects, and humidity. Holes for wires should be filled in with clay putty, and the desiccant in the box should be replaced regularly. A closet dehumidifier can also be used, if there is enough space in the box (Photo 1.2-13).

Tips 1.2-9

1.2.6 Other

Paths

For the conservation of vegetation and soil, paths should be established for routes that are frequently used by people, such as paths between the hut and the tower, from the parking area to the hut or tower, and for approaches to observation equipment installed on the ground. Paths are indispensable in wetlands or rice paddies, where a boardwalk is often installed (Photo 1.2-14). Careful consideration of factors, such as whether a boardwalk is required or not, is also needed in a forest site to ensure conservation of soil and vegetation around the tower over the course of time.

An important point to remember while maintaining facilities on an agricultural land is to avoid losing tools and metal fittings (clamps, bolts, nuts, arms, piles) that are used for fixing and supporting the tower and for measuring appliances and cables in the fields. Lost items such as these can hinder agricultural work, damage agricultural machinery, and possibly, injure workers. Even in an area where a rental fee is paid, disruption to crops and soil should be minimized. It is not pleasant for a landowner or manager to have his land damaged, even if compensation is provided. Long-term observational studies on a private land require such careful consideration.

Photo 1.2-14 Boardwalk installed around tower. (Tura, Russia)

Fences and security

A high tower should be fenced off from the surrounding area so that people cannot freely access the tower as there is a possibility that a person under the tower could be injured by a falling object. The fence also prevents casual passers-by from trying to climb the tower out of curiosity. A "No Trespassing" sign should be posted on the fence.

However, in case of an observation site located on an agricultural land, the tower is generally not as high and a fence may affect the observation results. The fence can also obstruct agricultural work (where machinery is used), so it is often not set up at such sites. But in case of an observation site located far from town, measures against theft or deliberate destruction of measuring instruments are needed. For example, the deployment of a security guard or the installation of a security camera is effective at forest sites. The former is an especially practical measure to take at observation sites located in countries where labor costs tend to be low.

Communications

It is better to provide a telephone line to the site to ensure emergency contact, although this is not necessary when a cell phone can be used. It is even better if there is an Internet connection. Data can be retrieved online, but for data integrity, it is safer to record and store the data onsite.