INTERACT

International Network for Terrestrial Research and Monitoring in the Arctic

Reducing the Environmental Impacts of Arctic Fieldwork

INTERACT Reducing the Environmental Impacts of Arctic Fieldwork

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Laura Lønstrup Frendrup *et. al.*

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AARHUS
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DCE – DANISH CENTRE FOR ENVIRONMENT AND ENERGY

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Photo: Helge Markussen

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About this guidebook

The environmental impacts of fieldwork at and around research stations may be small in comparison to the impacts of all other human activities and in relation to the often vast and remote areas in which the fieldwork takes place. However, fieldwork most likely have both global and local impacts. Examples of these are different means of transport emitting greenhouse gasses and other substances contributing to global Climate Change and pollution, while the fieldwork itself often impacts the local environment. In remote parts of North America, Greenland and Russia, the impacts of research might in fact in some areas be the most important local anthropogenic influence, e.g. in terms of damage to vegetation, erosion, disturbance to wildlife, emissions, waste disposal, nutrient enrichment, etc. The impacts of fieldwork is not only an environmental issue but may also influence other current or future scientific studies. Researchers should therefore aim to minimise the Climate Change contributions and all other environmental impacts of their science activities.

The *INTERACT Reducing the Environmental Impacts of Arctic Fieldwork* guidebook contains recommendations on how arctic scientists can reduce their contribution to Climate Change and other environmental impacts. The guidebook has been written in close cooperation with station managers of arctic and northern alpine and boreal research stations with the purpose of sharing their knowledge and best practices. The target groups for the book are scientists and other visitors to research stations in cold regions. However, the book can also be used by scientists doing research outside research stations.

The guidebook has thematic chapters describing different environmental considerations related to the fieldwork planning, the transport to and from the research site, staying at a research station and working in the field.

Additional information on fieldwork planning can be found in the *INTERACT Fieldwork Planning Handbook* and the *INTERACT Fieldwork Communication and Navigation* guidebook. The *INTERACT Practical Field Guide* also contains comprehensive information on how to prepare, plan and carry out fieldwork in the Arctic.

All INTERACT publications are available on the INTERACT website www.eu-interact.org.

1 Introduction and general principles

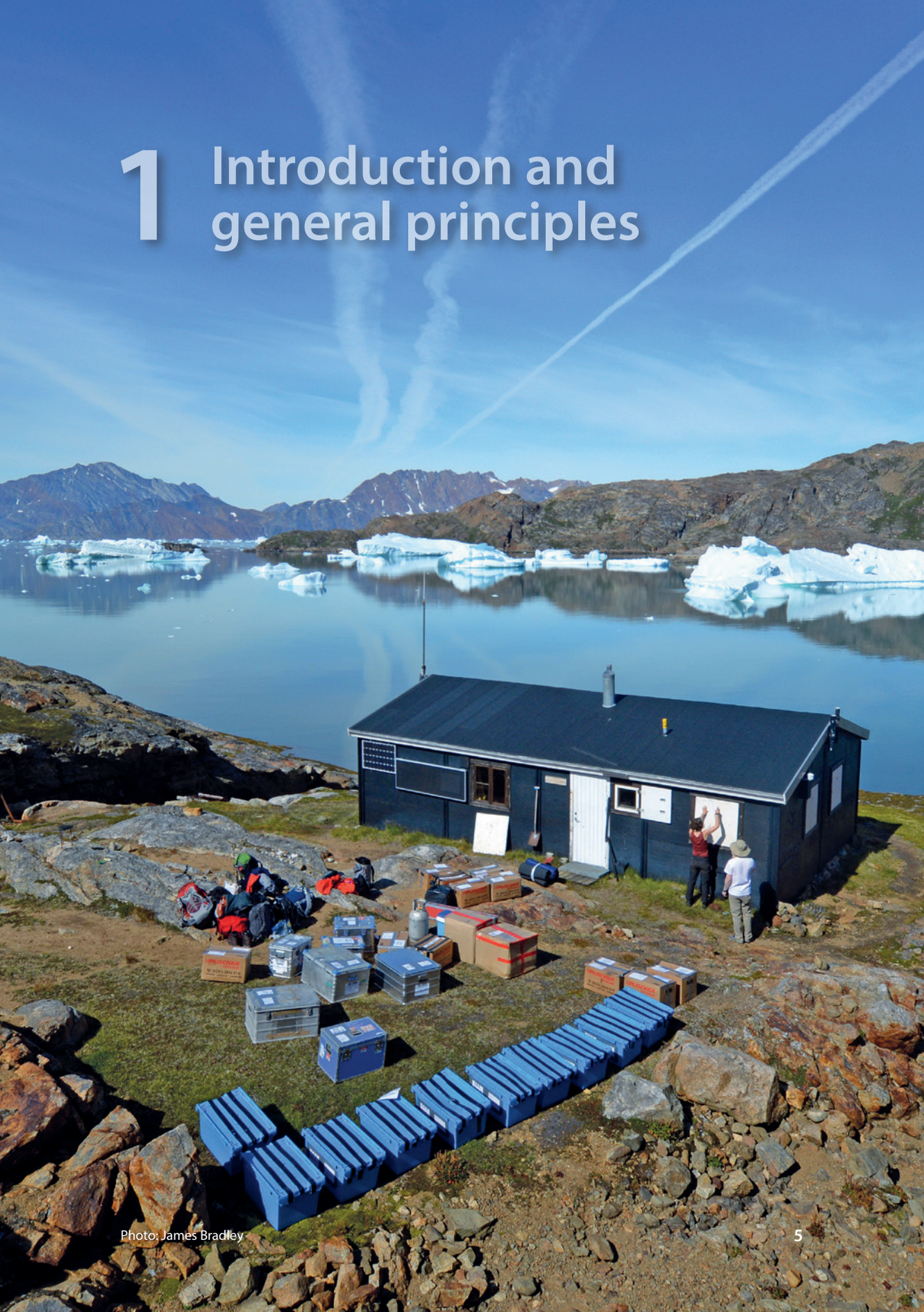

Photo: James Bradley

Ecosystems of northern cold regions are extremely sensitive environments, threatened by Climate Change, and with long recovery periods following disturbance or contamination. As a scientist, it is your responsibility to take care of the fragile environment you are working in, and to minimise your contributions to Climate Change.

The environmental impacts of a research project depends on the specific scientific activities and the related logistics. It is therefore important that you consider environmental issues as part of your fieldwork planning process.

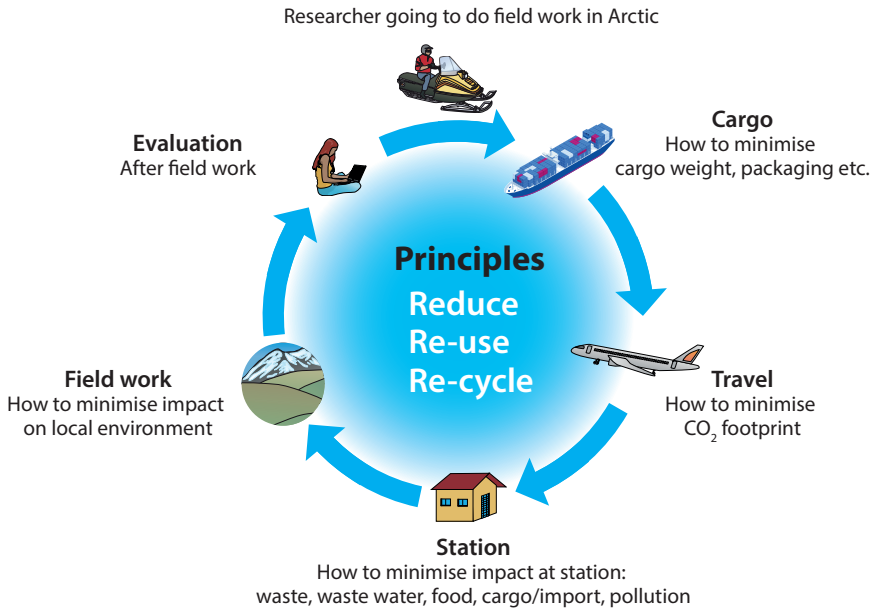

Figure 1.1 How to reduce the environmental impacts of fieldwork in the Arctic through reduce, re-use and re-cycle principles.

Environmental impacts

The environmental impacts of a research project can be divided into those with global and those with local implications. The global environmental impacts mainly relates to resource use and emissions (including release of greenhouse gasses), while local environmental impacts are more related to impacts on the physical landscape, natural habitats and the species living in the area.

The global environmental impacts include use of global resources for production (of personal equipment, instrumentation, chemical substances, water for food production, etc.), emissions from transport (of people, food, equipment, etc.) and emissions from the research station (from electrical power production, heating, garbage, etc.).

The production of food, personal items, vehicles and scientific instrumentation use resources extracted or produced in countries around the World. Energy is used to turn resources into useful products, while emitting greenhouse gases and other pollutants to the atmosphere and some to the local environment.

The transport of people and goods between home country and research stations, and in some cases between the research stations and field sites, also emit greenhouse gases and other pollutants to the atmosphere. The means of transport can include different types of aircrafts, ships/boats, trains, motorised vehicles, etc. that most often use fossil fuel and emit greenhouse gasses and polluting particles.

The global impacts of your project thus include resource use, pollution and greenhouse gas emissions (see section on transport).

The local environmental impacts are related to activities that pollute or damage the local environment or disturb local wildlife populations. Transportation, whether using vehicles or walking, may damage soil/vegetation, cause erosion, disturb wildlife, emit polluting particles to the local environment, etc. Research associated activities may change the environment by removal of samples/species, adding nutrients or isotopes, installing equipment, emitting chemical substances to the local environment, etc.

It can be challenging to address all environmental concerns, but you need to look into all activities of your research project (in relation to transport, activities at the station and activities in the field) and then consider as many potential impacts as possible. This guide will help you through the most common topics you need to address to minimise your environmental impact.

Reduce, re-use and re-cycle

General principles that should guide you when working on minimising your environmental impacts are to *reduce, re-use and re-cycle*. These principles are always relevant, but even more so in the Arctic, due to long transport distances and the difficulty of sustainable and safe disposal.

All resources, including clothing, equipment, chemicals, food, etc., have an impact on the environment, whether from occupying land for production or extraction, energy use and pollution from production and transport or impacts from use and disposal. Considerations about limiting the use of resources in your project can therefore help minimise environmental impacts from the origin of the resource all the way to the station.

Reducing garbage and waste production starts in your planning and procurement stages, by e.g. buying long lasting products and reducing wrapping without compromising safe transport. Plastic and polystyrene packaging should be reduced to a minimum. Wood and cardboard can often be reused or otherwise burned locally. Ask your suppliers to limit the amount of wrapping to a minimum.

Figure 1.2 Thorough planning is essential for a successful fieldwork with limited environmental impact. Photo: Morten Rasch.

Scientific equipment is generally expensive, sometimes fragile and often not designed for cold environments. If possible, buy products/equipment that are durable and can withstand the rough transport and climate that often prevails at remote stations.

If equipment breaks during transport or fieldwork, and cannot be repaired, it might still be useful as spare parts for others. Hence, consult the station manager to ask if the station has an interest in keeping it for such purpose. If not, bring it back home for repair/re-use or correct disposal. It is also possible to sell used equipment (or give it away) – but remember only to do so, if there is a good chance that it could have some value for the buyer.

Principles and examples of their use

Reduce – principles

- Give due consideration to the use of resources to minimise impacts from global resource use, transport and garbage production.
- Remove as much packaging as possible before heading to the field to reduce waste generation – especially light plastic or polystyrene materials may fly away in windy conditions.
- Bring only what you need, without jeopardising your safety by not having relevant clothing or safety equipment.
- Bring products and materials that are durable, can be re-used or re-cycled and are environmentally friendly.

Re-use – principles

- Before disposing anything, always ask yourself if the item could be re-used for other purposes by yourself or others, at the station or elsewhere. If the station is located near a town, used items may be given away to locals for free, e.g. via a local Facebook page. You should, however, make sure that you only give away things that can be used locally. If this is not the case, then you do not reduce your environmental impact and it is then more considerate to take care of the disposal yourself.
- Use materials that are worn out in their present function for new purposes, e.g. old linen as cloths, and glass/plastic containers from food as lunchboxes – instead of plastic bags for example.
- If you want to leave something behind for re-use at the station, make sure this is ok with the station management.

Re-cycle – principles

- Sort garbage in accordance with station guidelines and bring home things that cannot be handled by the station.
- Gather your used batteries to dispose them correctly – either at the station's common battery-collection (if such exists) or by bringing them back home.

Legislation, rules and guidelines

Authorities in many countries have regulations concerning environmental protection. Similarly, many research stations develop rules and guidelines to minimise the impacts of station operations and science activities.

You may therefore need to obtain permit(s) or approval(s) from national or local authorities, local communities or the research station for various activities. These include access to specific areas (e.g. protected areas/reference sites), use of drones, installation of field instrumentation, collection of plant/soil/water samples or species, collection of genetic resources, handling of wildlife or import/export of equipment and scientific samples. Hazardous substances are often subject to special legislation.

Along with environmental considerations, it is important that you also pay attention to the local culture, traditions and heritage. Most cultural remains in the Arctic are protected by law and cultural heritage sites should not be disturbed in any way, unless you have a permit to study them. As a newcomer, you will probably not be aware of all local traditions or be able to see all local cultural remains. Before you start your fieldwork, it is therefore always a good idea to ask locals and/or station staff about how to engage with the local community and if there are specific sites that you should be aware of.

Always read the stations' practical information to visitors, station manual or similar documents carefully as these often contain information on required permits, rules and guidelines for conducting research in the area.

Environmental screening

In the permit application process (for authority permits), you may be required to provide information about how your fieldwork complies with environmental regulations, how it will impact the local environment and how you intend to mitigate these impacts. This is particularly the case for protected areas, but it may also apply to other areas, including research/monitoring sites and reference areas. Check the station manual or ask the station manager to find out if there are any particular regulations that you need to adhere to, and what paperwork you might need to complete before you can get a permission from the authorities to work in the area.

Many research stations also ask applicants to describe potential impacts and intended mitigation efforts as part of the application process. Note also that some funding agencies require that you complete an environmental review before your project can be approved/funded. Make sure that you complete the relevant documentation and obtain all required permits before you begin your fieldwork.

To make an environmental screening of your project, you have to list all project activities and their potential impacts. Then you have to carefully evaluate their relevance and what you can do to minimise their impacts.

Types of activities and impacts that should be included in an environmental screening

- Travel to and from station.
- Travel to and from field site(s).
- Instruments and personal equipment.
- Chemicals.
- Personal hygiene products.
- Field instrumentation.
- Sample/species removal.
- Manipulations.
- Field camps.

An overview of your possible impacts will enable you to be more aware of the environmentally critical activities, how to reduce the risk of their occurrence and how to mitigate their impacts.

Note that some stations may already have standards for doing an environmental screening of the potential impacts of research projects. If that is the case, you should use them – at least as a supplement to your own assessment.

Choice of station

The first step for you, as a researcher intending to minimise the environmental impact of your research project, is to choose a suitable research station for your fieldwork and at the same time seek to minimise emissions from the transportation of people and equipment.

Choosing a station/site that suits your research aims depends on a number of factors, including presence of specific environmental features (e.g. habitats, species and permafrost), available research infrastructure, existing background data, legislation relating to fieldwork, logistics, budget, etc.

The station/site you choose, is likely to be located far away from where you live and the transport of team members and equipment will often require the use of one or more means of transport (e.g. car, aircraft, ferry, cargo ship), which likely will be running on fossil fuel. Hence, choosing a field site as close to your home as possible can in itself shorten the distance needed to transport equipment and people, and thereby limit the environmental impacts of your project. The choice of research site does, however, also depend on your research aims, and it is therefore not always possible just to choose the station closest to your home.

Environmental considerations

- Is the station suitable for your scientific aims?
- Is it necessary to go there, i.e. are the data you need already available or could someone already being in the field conduct the relevant sampling for you (e.g. a station manager, a fellow scientist or someone from the local community)? Check out INTERACT's Remote Access or Virtual Access programmes as part of this process – https://eu-interact.org/accessing-the-arctic/ (see page 12).
- Is it possible to share means of transport with others to ensure that all available seats and space for luggage/cargo are being used? See e.g. www.isaaffik.org, where you can look for shared logistics options or post your own availability of free space that could be used by others.
- Can you reduce your impacts by choosing means of transport with least emission/pollution?
- Can you reduce your need for sending cargo by borrowing/renting some of the equipment needed for your fieldwork?
- Consult the station website, the station manager or fellow scientists to enquire about what is available at the station or in local communities.

After finding a suitable research station, you can start planning the often quite extensive logistics. Always read the environmental guidelines and other more general practical information for the station you want to visit. You might also consult with the scientific leader/station manager early in the planning process to make sure that you make the right choices in relation to minimising the environmental impacts of both your logistics and your science activities.

Information about INTERACT stations and access programmes

INTERACT Station Catalogue (https://eu-interact.org/publication/interact-station-catalogue-2020/)
The INTERACT Station Catalogue contains descriptions of all INTERACT stations, incl. ownership, location, surrounding landscape, history, data availability, local communities, access, general climate statistics and contact information.

INTERACT GIS (https://interact-gis.org/)
INTERACT GIS makes it possible for you to search for research stations with specific environmental features, e.g. climatic zone, presence of permafrost, presence of glaciers, tree-line and other natural features. INTERACT GIS also allows you to explore, what science disciplines are being studied and what environmental features are being monitored at the stations.

INTERACT access programmes (https://eu-interact.org/accessing-the-arctic/)
INTERACT Transnational Access:
Through annual calls, scientists can apply for free access to stations offering this service. Grants cover travel to/from the station(s) and accommodation at the station(s).

INTERACT Remote Access:
Through annual calls, scientists can apply for assistance to collect samples/data at the stations offering this service. The scientists shall provide descriptions of the work to be done and the necessary instrumentation. Station staff will then do the fieldwork.

INTERACT Virtual Access:
Offers free and open access to data from a large number of INTERACT stations (https://eu-interact.org/accessing-the-arctic/virtual-access/).

2 Transport

Photo: Morgen Seag

Research projects have different needs for transport, i.e. (i) bringing people to and from the station, (ii) bringing cargo to/from the station, and (iii) bringing people, gear and instrumentation between the station and field site(s).

Motorised transport most often run on fossil fuel, emitting greenhouse gasses and other chemical compounds contributing to global Climate Change and pollution (including air quality and noise). Emissions include carbon dioxide (CO_2), nitrogen oxides (NO_x), sulphur oxides (SO_x), carbon monoxide (CO), particulate matter (PM), Volatile Organic Compounds (VOC) and soot.

It is beyond the scope of this short guidebook to provide guidance on carbon footprint calculations and cover in details the environmental impacts of different means of transportation. However, as a general rule of thumb, you can use the 'Power' column in Table 2.1 to roughly evaluate the energy consumption of different means of transport. Another easy to understand illustration is given in Figure 2.1, based on UK conditions.

Table 2.1 Energy efficiency of different means of transport. 'Power' is energy per time unit. You can therefore convert the numbers in the 'Power' column into kilojoule per hour per person by multiplying the numbers with 3,600. Please notice that the numbers in the table are only guiding and that large differences occur within each transport category.
Source: www.ethify.org.

	Power (kW/Person)	Speed (km/h)	Efficiency (km/kWh)
Walking	0.04	4	100
Bicycle	0.08	18	225
Ship	5	25	5
Train	8	100	13
Bus	15	80	5
Car	40	120	3
Aircraft	200	700	4

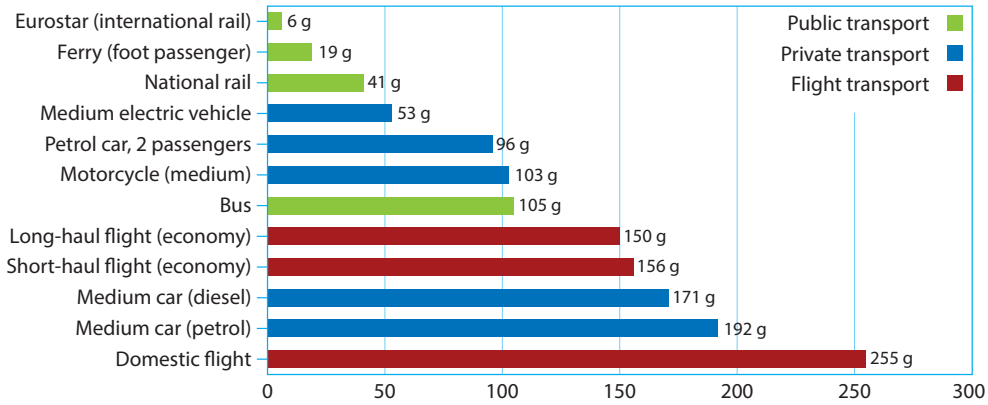

Figure 2.1 Carbon footprint (g carbon emitted per km transport) for different types of transportation. Note that increasing the number of passengers per vehicle in private transport can reduce the emission levels per person. Source: UK Department for Business, Energy and Industrial Strategy. Greenhouse gas reporting: Conversion factors 2019.

Notice that a carbon footprint calculation is not an easy task and the two rules of thumb examples given here both depend on a large number of presumptions. It is for example important, whether electrical energy is produced by a fossil fuel power plant, a nuclear plant or sustainable energy (which varies from country to country). For cycling and walking your carbon footprint is dependent on your diet, and for flights, the flight distance is important (because take off consumes much more energy than cruising).

Carbon footprint compensation schemes exists and are promoted as a way to reduce your carbon emissions. Schemes differ in scope and focus (e.g. tree planting, renewable energy, etc.), and concerns have been raised over efficiency and environmental and social sustainability. Therefore, prioritise to reduce your emissions and if you venture down the compensation road, do this carefully and select a scheme with proven effects or international standards.

The sections below contain information on how to reduce the environmental impacts of your transport on both local and global scales.

Figure 2.2 DeHaviland DHC-6 (Twin Otter) aircraft on the way to a field site in Ellesmere Island, Canada. Photo: Morten Rasch.

Transport of people

If you, and your team members, are travelling to a research station, you should consider ways to reduce transport emissions to the environment.

Environmental considerations

- Choose the least greenhouse gas emitting means of transportation to/from the station and field sites.
- Walk, cycle, ski or run when possible.
- Prioritise public transport (especially trains are energy efficient).
- If using a car, coordinate transport to fill up all available space.
- If you are working in a team, consider carefully how many people needs to go to achieve the research aims.
- Check in advance, what equipment is available at the station or can be borrowed from others working there (e.g. scientific equipment and camping gear).
- Pack as light as possible without compromising safety or science aims.

Transport of cargo

The amount of scientific equipment needed to conduct your fieldwork can be in large volumes, heavy and/or contain harmful chemical substances. It may therefore be necessary to send at least some of it as cargo.

Be aware that there may be legislation relating to the transport of cargo, especially when crossing country borders. Legislation governs customs and what items can be brought in and out of a country (e.g. radioactive substances, specific dairy products, plants and animals, genetic resources and specific equipment) as well as specific precautions to be taken during the transport (e.g. of hazardous substances).

Note also that the export of samples may also be subject to legal regulation. The country in which you do your research might have legislation concerning what is legal to bring out of the country, and your home country might have legislation concerning what to bring into the country. Such legislation has the purpose of preventing spread of diseases, invasive species, commercial exploitation of genetic resources without formal agreement, etc. If you have the least doubt concerning export/import of your own samples, contact relevant professionals in your home institution, station staff, relevant customs and/or a shipping company. You might break the law by not doing so.

Figure 2.3 Cargo ship bringing research equipment to Qeqertarsuaq, West Greenland.
Photo: Morten Rasch.

Environmental considerations

- Check if you can borrow/rent equipment or buy materials at the research station, before sending your cargo to the station.
- If possible, send cargo as surface freight instead of with aircrafts. Ships, trains and trucks use less fuel than aircrafts per kilo of goods being transported. When using surface transport it is important to send cargo well before the fieldwork, in order for the freight to arrive in time.
- If you need to send equipment, reduce weight and packaging, without compromising a safe transport.

Dangerous cargo

All countries have legislation concerning the transport of dangerous cargo/goods. Dangerous cargo/goods is cargo/goods that, when transported, possess a risk to health, safety, property or the environment.

Dangerous cargo/goods needs to be handled with utmost care and consideration of its dangerous nature, since any inappropriate packaging, mis-declaration, mis-communication or incorrect documentation is illegal, might have severe consequences and could be disastrous to human lives on shore or on a ship and/or to the environment.

Dangerous cargo/goods are divided into nine classes, according to International Air Transport Association (IATA) and International Maritime Organisation (IMO):

- Class 1: Explosives.
- Class 2: Gases; compressed, liquefied or dissolved under pressure.
- Class 3: Flammable liquids.
- Class 4: Flammable solids; substances liable to spontaneous combustion; substances, which, in contact with water, emit flammable gases.
- Class 5: Oxidising substances (agents) and organic peroxides.
- Class 6: Toxic and infectious substances.
- Class 7: Radioactive materials.
- Class 8: Corrosives.
- Class 9: Miscellaneous dangerous substances and non-classified materials.

If you have to send any cargo/goods that falls into one or more of these categories, you need to be extra cautious and follow the specific guidelines for shipping these.

Always check the transport requirements well in advance to allow you to provide the required documentation and prepare safe packaging for the shipment. This is for example important if you send chemicals, batteries and/or bottled gasses (even if it is only very small amounts and/or products that you can buy in a normal supermarket).

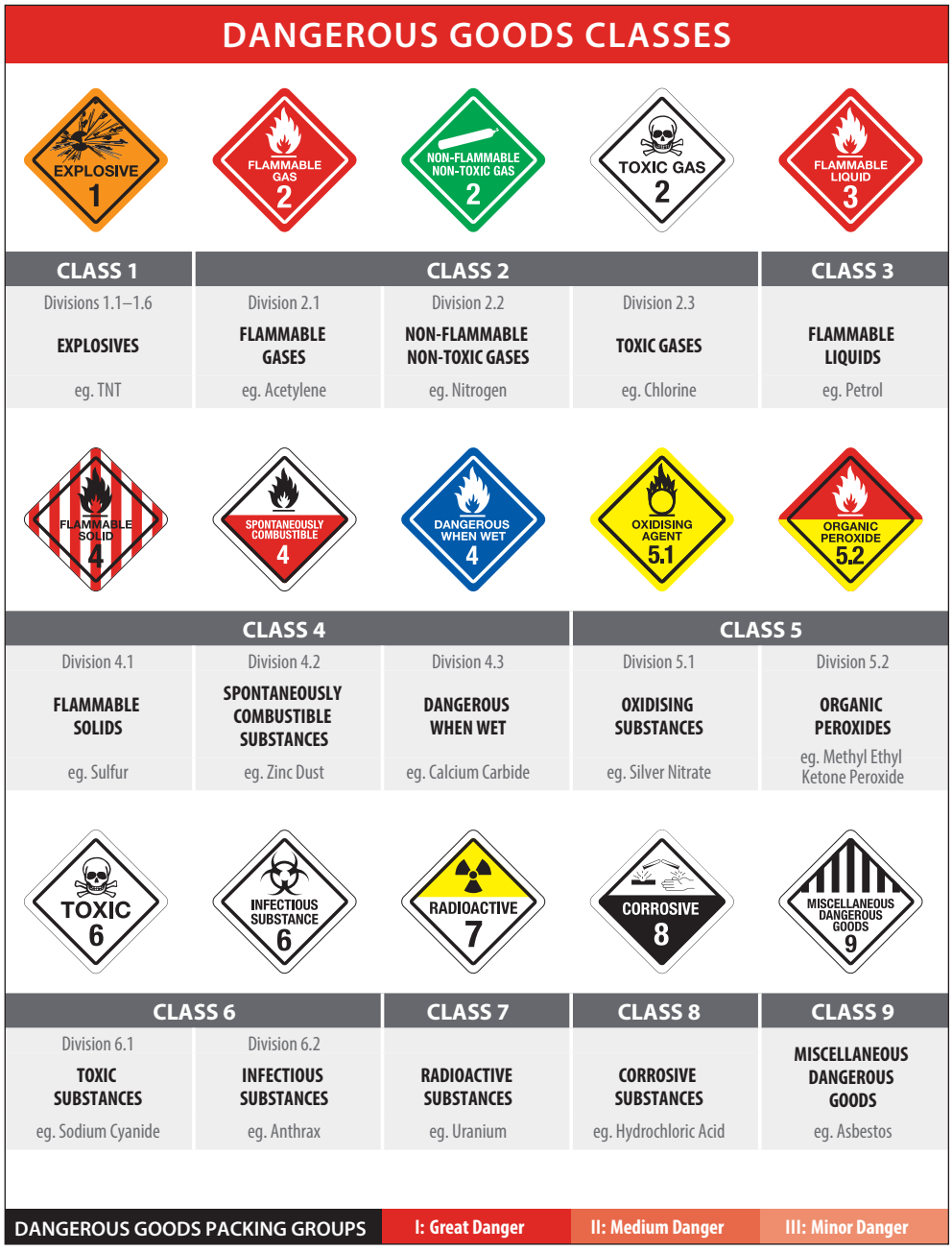

Figure 2.4 Dangerous Goods Classes according to the International Air Transport Association (IATA) and the International Maritime Organisation (IMO). Source: ChemAlert.

It is not always an easy task to make proper declarations for dangerous cargo/goods and it is illegal (and dangerous) to send wrongly declared/marked dangerous goods. If you plan to make the declaration yourself, it is therefore strongly recommended (and generally required by law) that you complete a course on dangerous goods declaration before starting out. Alternatively, you can consult a specialist in your own organisation or you can involve a professional shipping company to check up on relevant regulations, do the relevant declaration, mark the cargo/goods properly, pack it properly and choose the most appropriate mean of transport.

Figure 2.5 The internationally recognised marking for Environmentally Hazardous Substances.

Notice that the dangerous cargo/goods classes have not been developed mainly for environmental protection, but mainly for safety. The International Maritime Goods Code has a marking for *Maritime Pollutants*, while the International Air Transport Association has a marking for *Environmentally Hazardous Substances*.

Local transport

The way in which you can get to your field site depends on the distance to the site and the local infrastructure (roads/tracks/paths/boardwalks and available vehicles). Motorised transport may be needed to reach remote field sites or cross larger bodies of water (sea, lakes, rivers). If running on fossil fuels, the means of transport will emit greenhouse gas and other pollutants to the environment.

Figure 2.6 Transport to a field site with an All-Terrain-Vehicle in Meinypilgyno, Russia.
Photo: Evgeny Syroechkovskiy.

Figure 2.7 Transport by foot back from a field site at CEN Boniface River Field Station, Canada.
Photo: Melanie Jean.

To reduce the wear and tear of travel in the field, you need to balance the level of disturbance with the robustness of the vegetation/ground. If you work in a remote area with few other people, it is recommended to walk along different routes not to create paths, but if you work in an area with high level of activities, it may be better to use the same path to reduce the area being affected. Sometimes stations install boardwalks, so use these if available. Always check the station manual for travel guidelines around the station or ask the station manager, if you are in doubt.

Environmental considerations

- Consider using drones or automated measurements to reduce the need to go into the field.
- Walk or ski, if possible.
- Use electric vehicles.
- Use designated or recommended walking/driving paths where these exist.
- Avoid or minimise damage to terrain/vegetation and disturbance of wildlife.
- Drive on snow covered or frozen ground if possible. Driving on sea, lake and river ice is also an option given that the ice is thick enough (only do this if adviced by the research station or knowledgeable locals).
- Avoid driving on soft ground or particularly vulnerable vegetation. It may take decades or longer to restore deep tracks. Wet areas (like fens) are more affected by transport than dry areas (like heath). However, the wet areas recover much faster than dry areas.
- Use snowmobiles on snow in winter to transport larger installations or equipment to your field site to avoid damaging the terrain/vegetation.
- Flying with helicopters and fixed winged aircrafts should be done at an elevation of more than 500 m above the terrain, except during take-off and landing or when it is crucial for the science activities. Avoid, to the widest extent possible to fly in areas with wildlife (especially in sensitive periods, e.g. breeding/calving seasons, moulting season, etc.).
- Reduce transport back and forth from the field by sharing transport (to fill capacity).
- Do extra-long field days (with due consideration to safety issues caused by fatigue), and/or camp close to your field site(s).
- Talk with other researchers at the station about possible shared interest in sampling areas. They might be able to do some of your measurements/sampling (and thereby reduce the number of people going to the site).

3 At the research station

Photo: Denis Sarrazin

Minding your use of resources is always relevant, but in the Arctic and northern alpine and boreal zones even more so. The northern ecosystems are fragile, and the infrastructure and services supporting everyday life in local communities and at research stations are not always managed in the most sustainable way, as the remote and isolated location complicates this. This relates to e.g. infrastructure construction and maintenance, provision of electricity, heating, and water and waste management.

Power use and sources

Only a few arctic countries use renewable energy as their primary source of electricity, e.g. geothermal energy and/or hydropower. In general, diesel dominates electricity production in the Arctic, in particular so at research stations. Diesel normally have to be transported either by sea, truck or sometimes even by airplane, adding even further to the environmental impacts that the actual burning of the diesel impose.

Diesel based electricity in smaller communities is generally produced by small-scale diesel power plants distributing the energy to a local grid. Remotely located and 'off-grid' stations have to produce heating and electrical power themselves. Hydrocarbons (diesel, oil, gas, etc.) are normally used in oil/gas burners to provide heating and in generators to provide electricity (for electrical appliances, heating, etc.).

A fuel powered generator emits gases like CO_2, CH_4, NH_3, NO_x, particulate matter, SO_2, Black Carbon and Volatile Organic Compounds (VOCs), which contribute to Global Warming and local pollution levels. Emissions may also affect research experiments and monitoring at research stations, and noise from generators may also affect especially larger animals.

Some 'off-grid' research stations get at least part of their energy from renewable energy sources (such as solar irradiation and wind). These technologies often require either large storage capacity (generally in batteries) or a backup power source, when electricity production and demand do not match up.

Figure 3.1 Diesel generators at Toolik Field Station, Alaska, USA.
Photo: Morten Rasch.

Figure 3.2 Solar panels for sustainable power production at Kluane Lake Research Station, Canada. Photo: Matthew Ayre.

Figure 3.3 Backup batteries for sustainable energy storage at Kluane Lake Research Station, Canada.
Photo: Matthew Ayre.

Even at stations being completely powered by renewable energy (from grid or produced by the station) it is still important to save energy – because energy systems at stations have a maximum production capacity and the renewable energy from regional grids comes with a cost for the kW's being used. Stations may therefore have regulations concerning the use of energy, and it is therefore always a good idea to reduce your energy use.

Small and simple measures can help you to reduce your use of electricity and heat.

Environmental considerations

- Follow the guidelines set by the station relating to energy use (if any).
- Switch off lights and all equipment running on electrical power, including computers, when not in use. Do not use sleep mode on computers, turn them off.
- Unplug chargers of phones, computers and equipment, when not in use.
- If possible, ensure that all equipment is as energy efficient as possible and is in use only when necessary.
- Regulate the temperature in your bedroom and living spaces to recommended levels (e.g. 18 °C for bedrooms and 20 °C for living rooms). Ensure that radiators and other heaters are not blocked by clothing or furniture.
- Make sure refrigerators and freezers are set at the right temperature, not too cold, and remember to only have them open for a short time. Refrigerators and freezers for samples should be turned off, when not in use.
- Take short showers to reduce energy used to heat the water (and reduce water consumption).
- Use laundry machines only when needed and filled to full capacity. Use clothes lines instead of tumble dryers.
- If you cook yourself, bring food that is easily prepared with limited cooking/baking time.
- Use small wind turbines or solar panels (and batteries) to power field instrumentation.
- Use rechargeable batteries (in torches, headlamps, etc.) and remember to bring a charging station (if this is not available at the station).

Water use and disposal

Water is generally not a scarce resource in the Arctic, but the liquid form of water might be scarce at least during part of the year. Part of the arctic region is furthermore classified as Arctic Desert with little precipitation and hence may have a limited supply of fresh water.

In the Arctic, most precipitation is likely to fall as snow and stay in its frozen form except for the warmest summer months. Hence, ice/snow may have to be melted before it can be used in a household or at a research station. Regardless of the water source (municipal or from own lake/well/snow), energy is used to transport, rinse, heat and dispose the water used at a research station. Hence, consumption of water should be minimised.

Besides the everyday need of water for cooking, dish washing, showering, flushing toilets (if relevant), washing clothes and drinking, you might also use a substantial amount of water for laboratory purposes.

Waste water is water that has been used by humans and may contain physical, chemical and biological pollutants. Waste water originates from washing, from the use of toilets, from kitchens, laboratories, workshops, etc. Waste water pollutants include macro solids, heavy metals, organic material, inorganic material, gasses, toxins, pharmaceuticals, micro-plastics, etc., all of which can be harmful for both humans and the environment. In the Arctic, the ability of the ecosystems to naturally treat discharged waste water is lower than elsewhere due to slower bacterial breakdown caused by low temperatures. Hence, limit the production of waste water and treat it properly for the protection of the environment.

Arctic waste water systems are not always environmentally sustainable. In fact, treatment is often inadequate or completely lacking, even on a municipal level. This means that waste water often is emitted to the environment without proper treatment, adding nutrients and potential hazardous substances to the local environment. The (often) remote location of research stations means that many stations are not connected to a municipal sewage / waste water system – if such a system even exists. Hence, remote research stations have to manage the waste water they produce themselves. This can be challenging and costly to do on a small scale, and not all stations have yet a sustainable waste water handling system.

Stations connected to a municipal water supply and sewage system often pay for these services. Even at these sites you thus have to reduce your water use as much as possible.

Small and simple measures can help reduce the amount of water and waste water that needs to be treated.

Figure 3.4 Sewage system in the small settlement Tasiusaq, Greenland. Photo: Janne Fritt-Rasmussen. **Fjord dumpsite for toilet sewage in Nuuk, Greenland.** Photo: Elmer Topp-Jørgensen.

Figure 3.5 Laundry outside Arctic Station in Qeqertarsuaq, Greenland.
Photo: Morten Rasch.

Environmental considerations

- Follow station guidelines on water use and disposal.
- Take only brief showers. Shower only when needed and turn off the water, while soaping yourself.
- Do not leave taps running (e.g. when brushing your teeth).
- Report any leaks in water systems immediately, no matter how small.
- Kitchen: Fill up the dishwasher to full capacity. Have a personal cup that does not need washing up after each use. Swipe off leftovers instead of removing it under running water before filling the dishwasher. If washing up by hand, use a tub, not running water.
- Clothes: Fill up washing machines to full capacity, potentially by asking your fellow scientist at the station, if they have anything to be washed. Wash at low temperatures and only when needed.
- Use environmentally friendly detergents and personal care products.
- Avoid emitting hazardous substances with the waste water (export to proper treatment facility).
- Use adequate amounts of water to keep laboratory and other facilities clean, but avoid excessive use.

Waste handling

Waste from a research station includes everyday household waste, packaging wrappers, laboratory one-time-use equipment, chemical substances (and their containers), worn out scientific equipment, batteries, etc. Altogether, the waste can become a toxic mixture of materials that can have severe effects on both human health and the environment, if not handled correctly. Handling waste correctly can be challenging and expensive at stations not supported by municipal waste handling services.

Figure 3.6 Local dump in the small settlement Tasiusaq, Greenland.
Photo: Janne Fritt-Rasmussen.

Always read the station guidelines to check how to handle the garbage you produce. Generally, paper, cardboard, glass, plastic, metal, wood, electronics and batteries can be collected for recycling.

Waste cannot be avoided, but the amount can certainly be reduced through proper planning and awareness in corporation with the research station.

Environmental considerations

- Follow the 'reduce, re-use and re-cycle' principles (see Chapter 1).
- Consult the station's waste policy before you pack, and follow the guidelines once at the station. If guidelines are not readily available, ask for them.
- Sort the garbage you produce (paper, metal, electronics, etc.) in relevant categories for possible recycling and/or proper disposal.
- Re-use option examples:
  - Reuse plastic bags and containers if possible.
  - Store cardboard boxes brought into the station for homebound transport of samples and equipment.
  - Check the "forgotten clothes" shelf if you have lost some personal clothes (or forgot to pack it) and need a replacement.
- Bring out any garbage fractions that cannot be handled by the station.
- Chemicals and hazardous materials, need to be appropriately packed, labelled and shipped back to your home institution for proper disposal (unless handled by the station).
- Consult the station staff if you have any doubts about your waste.

Biodegradable

Figure 3.7 There are many different brands of environmentally friendly personal care products. Select one with a trusted certificate before buying. Repack adequate amounts in reusable containers.
Photo: Josefine Lenz and Svenja Holste.

Personal care and equipment

Read the station's practical information, when you are packing for your travel. It might contain information on what to bring and what not to bring. This will ensure that you are not packing unnecessary clothing, gear and equipment, and hence are transporting unnecessary weight/volume. Always pack as light as possible to reduce weight. If the station you are visiting has washing machines or a laundry service, you do not need to bring clean clothes for your entire stay at the station.

Environmental considerations

- Personal care products like shampoo, soap, makeup, sunscreen and mosquito repellents contain chemical components. Always use the environmentally friendly version of these and limit the use. Ask in advance if the station provides these items, so you do not bring unnecessary weight.
- Bring multiple use items like foldable food boxes (to reduce use of plastics bags) and reusable water bottles (to avoid to use several light-plastic ones).
- Be aware that clothes made of fleece material or with plastic print may contaminate the local environment with micro plastics. You may therefore consider to bring woollen clothes for insulation.

Chemicals and other hazardous substances

Chemicals, lubricants, fuel, etc., are used in laboratories, in workshops, in the field and sometimes for cleaning. Some chemicals can be extremely harmful to the environment, and it is therefore important to bring as little as possible and to adhere to product guidelines for transport, use and disposal. The research station may have its own supply of commonly used substances and may have regulations on their use, so make sure to check this before you head for the station.

Environmental considerations

- Use eco-friendly alternatives where/when possible.
- Always know what chemicals you are using and how to use them – both for your own safety and for the environment.
- Make sure that the chemicals are labelled correctly, according to international and national standards (see Chapter 2).
- Follow guidelines for laboratory use and disposal of chemicals and hazardous substances (and their containers).
- Use spill trays (in laboratories, workshops and in the field) and never emit chemicals or hazardous substances to the environment. If a spill occur, stop it from becoming worse, notify station management immediately and initiate a clean-up.
- Never use chemicals that has been mixed by others, except by members of your own team (e.g. Borax buffered formaldehyde left by another project). Make your own solutions and discard it yourself in a proper way.
- Be extremely cautious in your use of stable isotopes and radioactive materials (even in very small amounts) in the field. It might contaminate the area for many years and as such lead to erroneous results in future projects. In principle, this is also the case when adding nutrients or other chemicals to the soil. Always get permission from the station management for such experiments and make sure that they have exact information on the location of the experiment.
- Do not wash chemicals into local water sources – bring them back to the research station for proper cleaning and disposal.

Figure 3.8 Spill trays should be used when handling hazardous substances.
Photo: Morten Rasch.

4 In the field

Photo: Jon Leithe

Fieldwork comes in many forms as researchers have very different scientific aims with their research, different travel distances to their field site (or sites), different means of transport, different scientific gear to carry and operate, different amounts of samples to collect and carry, different working hours, etc. The potential environmental impacts of research projects therefore differs immensely and scientists need to consider the specific impacts of their field work in relation to environmental pollution, wildlife disturbance, protected areas, sensitive habitats and species, and also how to interact respectfully with local communities.

Your behaviour in the field

Fieldwork may impact the natural environment in many ways, e.g. through transport (motorised and on foot), camp life, instrumentation, sampling and experiments. These impacts may result in local pollution, erosion, destruction of sensitive habitats, disturbance of sensitive species, change of local hydrology patterns and impact on future research and monitoring in the area. Your behaviour in the field should therefore help minimise these impacts.

In general, you should strive towards leaving your field site in the same condition as when you arrived. You will of course need to take your samples, establish your instrumentation and/or do your treatments, but if you act considerate you will definitely make fewer lasting imprints. Consider the following, without compromising the quality of your fieldwork:

- Reduce the area you affect to a minimum.
- Reduce the size and numbers of samples to a minimum.
- Prevent spills and minimise the amount of substances added in approved manipulation studies.
- Be considerate about your transport to/from the site(s) to minimise surface impacts and disturbance of wildlife.
- Be as cautious, when you clean up, as you were, when you established your instrumentation and took your samples.

Figure 4.1 Freezing plant samples near Longyearbyen, Svaldbard, Norway. Photo: Jose Ignacio Garcia Placaola.

Most research stations have guidelines for fieldwork, so make sure that you are familiar with these before entering the field.

Environmental considerations

Habitat and wildlife disturbance

- Minimise the disturbance of wildlife. In general, it is advised to maintain a distance of at least 200 m to any wildlife. Move away if animals show signs of distress. Pay special attention to larger wildlife and sensitive areas (e.g. nesting/breeding areas, important foraging areas, moulting areas, haul-out sites and denning areas). Do not handle wildlife unless you have a permit to do so and the required skills.
- Minimise damage to vegetation, terrain and cultural features. Do not remove any plants, geological specimens or artefacts from historical sites, unless you have a permit to do so.
- Minimise disturbance from transport in the field, both on foot and motorised (see Chapter 2 for additional recommendations).
- Restore any damage you may inflict on the environment to minimise impact and avoid it getting worse (e.g. by starting erosion). Inform the station manager about the damage to allow implementation of relevant precaution measures.
- Do not build cairns or modify the environment in any way that is not an approved part of your fieldwork.

Emissions and waste at field camps

- In general, any garbage produced, while you are in the field, shall be packed and brought back to the station, where it shall be sorted for re-use, recycling or disposal according to the research stations' procedures. However, in some areas, it might be legal, and environmentally most appropriate, to burn garbage and to dispose harmless liquids into a river or the sea. Ask the station manager about local procedures/regulations.
- Reduce the possibility of spilling pollutants (e.g. harmful chemical substances, radioactive materials and isotopes) in the field by using appropriate spill trays or secondary containers.
- Do not emit harmful chemicals to waterways (lakes, streams, etc.). Do not wash chemical containers in local water sources – bring them back to the research station for proper cleaning.
- If washing up or bathing, use environmentally friendly products and in low amounts.
- Never drop litter (this also includes cigarette butts) and pick up any litter you find on your way.

Sampling and manipulation studies

It is of particular importance to describe and geo-reference extractive activities and manipulation studies that may impact future science in the area (e.g. adding nutrients, artificial warming, snow removal, soil sampling and specimen sampling). Such studies should only be done with permission from the station management (and in some cases also the relevant local or national authorities), and the exact location and precise description of what has been done, should be communicated to the station, when the fieldwork is over.

Taking samples alters the micro-environment, from where the samples are removed. Be careful when taking soil and vegetation samples – do not remove more than you need.

Environmental considerations

- Removal of species (fauna and flora) must not be done without prior permission. Special attention must be given to threatened species for which collection of even few specimens may have significant impacts on the populations.
- Sampling of vegetation must be done with great caution to minimise the affected area – it is easier to restore smaller plots than larger ones, and smaller plots are less prone to erosion.
- Invasive sampling of wildlife should only be carried out with permission and only if you have the required skills. Handling should be short and efficient to minimise stress.
- Sampling of soil and permafrost samples may leave the ground vulnerable to erosion. Many smaller samples are preferred to few larger.
- Manipulation studies (shading, heating, adding organic and inorganic compounds, adding/removing snow, etc.) require permission as it may affect the results of future research activities in the same area.
- Remember to report any manipulations or emissions to the local environment to station staff (and if relevant also to the local authorities).
- Remember to have relevant export/import permits if you bring or ship samples to another country.

Field instrumentation

Some research projects require installation of scientific equipment for a shorter or longer period. Often, such installations in the field have to be approved by local authorities and/or the research station. When planning to install scientific equipment, it is important to consider the impacts on the flora and fauna surrounding the installation.

Most fixed installations have to be visited relatively often for download of data, maintenance, etc. Hence the sites, where fixed installations are situated, are exposed to wear and tear, which can influence the environment and the results of the science being conducted. To protect the site around a fixed installation, balance disturbance with vegetation robustness to minimise wear (see Chapter 2). For long-term experiments, it should be considered to establish a boardwalk/walk way to minimise damage to vegetation and soils. Be aware, however, that boardwalks or walkways make use of substantial resources

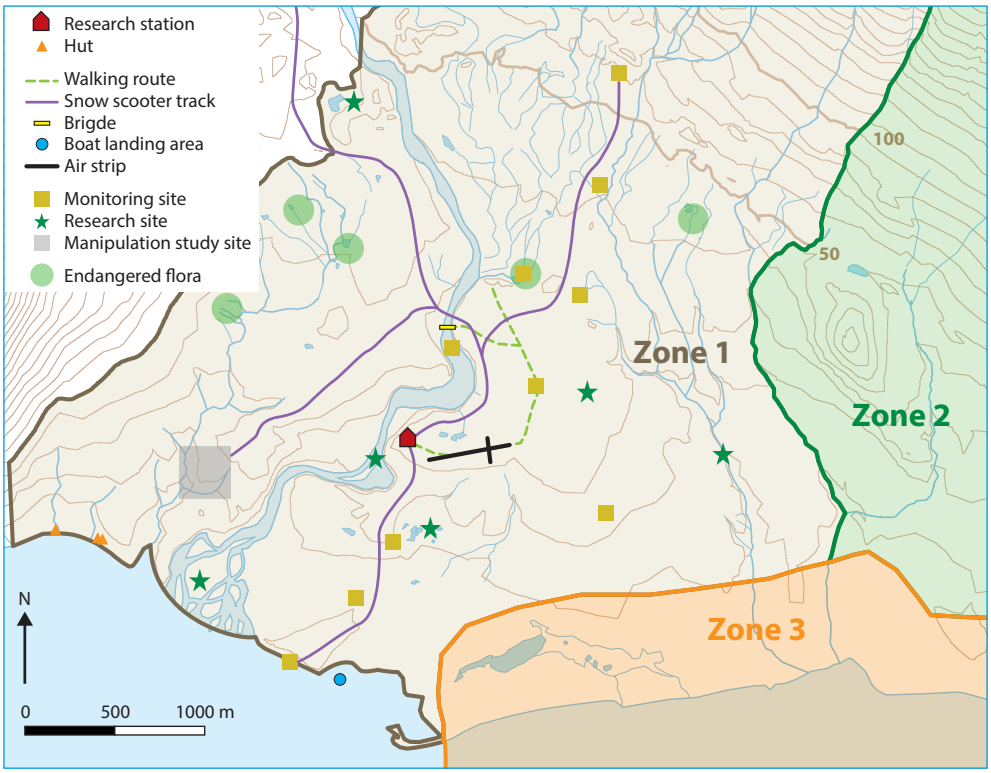

Figure 4.2 Thought example of a station land use map informing visitors about infrastructure and logistics, land use zones, sensitive areas and science sites. Zone 1– Bird protection zone: Access prohibited between 20 June and 10 August. Zone 2 – Minimum impact research area: Access restricted and only with prior approval. Zone 3 – Primary research and monitoring area. Restrictions apply in areas with endangered flora.

that often have to be transported from elsewhere, maintained and disposed of properly. Furthermore, boardwalks can alter the micro-climate beneath, as they provide shade and prohibits precipitation from reaching the ground. Hence they might favour different vegetation and microbes than at the initial state. Similarly, fixed installations can also cast shadows, make reflections, make noise or act as a barrier, which might disturb wildlife.

Automated measurements (and drone and satellite based observations) and data transfer equipment may help reduce environmental impacts by limiting the need to venture into the field.

Some fixed installations may require electricity. This can be provided by the station (own production or from the local grid), by replacement of rechargeable batteries or from small renewable energy supply systems in association with the instrumentation (solar panels/wind turbines).

Remove research instrumentation from the field after your fieldwork (markers can be left, if you know you will come back and after acceptance from the research station/landowner). Ask the station manager (i) if you have to mark your field experiments /sampling

sites with pegs, (ii) if you have to register the position of your field sites and (iii) how to clean the area after use. Many stations have written procedures for this, but it is always a good idea to consult the station manager. Some stations prefer marking with pegs, others prefer a precise GPS position.

Battery types include conventional batteries and rechargeable batteries/power banks. Consider whether conventional batteries in your equipment can be replaced with rechargeable batteries, especially where these can be charged with a renewable energy source. Scientific equipment that can be carried to and from field sites with ease, could be charged between the trips to the field site. This could reduce the need for conventional batteries and hence reduce the amount of toxic waste and emissions if the local power supply is from renewable sources.

Environmental considerations

- Consider options for using renewable power sources for your instruments. Ask station managers what is available at your study site or what renewable energy source would be reliable (if any) at the specific site.
- Use rechargeable batteries wherever possible, especially if they can be charged with renewable energy. Batteries (both conventional and rechargeable) should always be disposed properly. If the station do not collect batteries, you should send them back home yourself (assuming that better disposal options exists).
- Solar powered power banks can be used for charging small electrical devices such as cell phones, small data loggers, GPS, etc.
- Scientific equipment is generally expensive and often fragile. Therefore, always bring the most commonly used spare parts both to make your fieldwork the most efficient but also to reduce the environmental impacts by suddenly having to ship spare parts fast – which normally would include transport by aircraft(s).
- Note that wildlife may damage instruments and wires (tilting instruments, chewing cables, etc.). You must therefore protect your installations if it is a risk in the area you will be working.

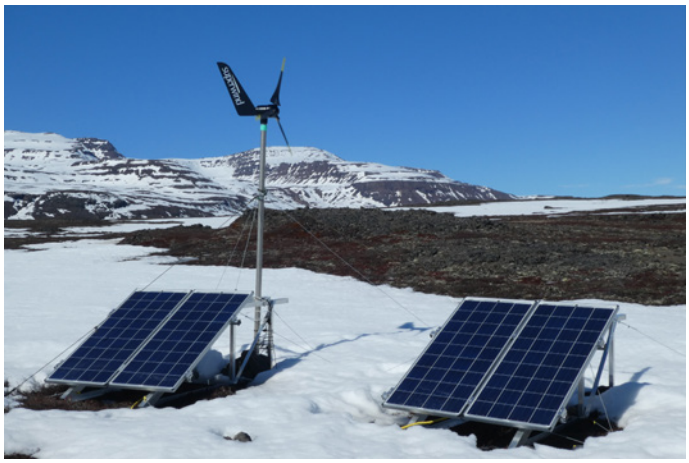

Figure 4.3 Solar panels and a windmill provides power for scientific instrumentation in Blæsedalen on the island Qeqertarsuaq, Greenland. Photo: Charlotte Sigsgaard.

Figure 4.4 Field camps should be kept clean and items stored properly to avoid contamination of the local environment.
Photo: Ruth Vingerhagen.

Field camps

Setting up remote field camps in cold environments require careful planning to ensure proper logistical support and a high level of safety for the field operation. The environmental impact of remote field camps varies according to their size, the science activities they support and the means of transportation used for moving to/from the field camp.

Long-term stays or repeated stays over a number of years in the same area can impact the local environment by e.g. damaging vegetation or changing local soil properties that may lead to erosion. Shifting tent location periodically may minimise impacts of repeated or prolonged use of specific sites.

Open fires are not always allowed, and if so ensure that it cannot spread and that it is completely extinguished before you leave an area. In some areas (like dry heath and forest), fire may burn underground for days or weeks and may lead to large wildfires.

Bring in your own fuel source, unless you are working in the boreal zone with plenty of firewood (and you are permitted to use it).

When packing up your campsite, there should be absolutely no sign of your presence left behind. Bring everything back with you to the research station or the nearest town.

Environmental considerations

- If raised on vegetation, move your tent every 3-5 days to minimise damages to the vegetation.
- If using fire to cook, make sure that the fire cannot spread and make sure that it is completely extinguished before leaving the area. Do not use local wood sources if close to the tree line, as this is unlikely to be sustainable given the slow growth rate.
- All garbage should be brought back to the research station or nearest town for proper disposal/treatment. In some cases, this might also include food waste.
- Used toilet paper must be buried in the ground, covered by rocks, or taken back to the station in a bag to prevent animals from reaching the remains.

Protected areas

Many stations are located in or close to protected areas (e.g. nature reserves, cultural heritage sites or science reference areas), which may have various restrictions and regulations in place. Stations may also have areas with restricted access to preserve a pristine environment or protect specific research activities.

Environmental considerations

- Make sure that you and your team are aware of areas with restricted access (e.g. protected areas, science reference areas, experimental areas (manipulation sites), etc.
- Make sure that you obtain all relevant permits to enter areas with regulated access and make sure you possess all other relevant permits for your specific study. Find information on permits of relevance for all eight arctic countries on the INTERACT homepage: https://eu-interact.accessing-the-arctic/arctic-fieldwork-permits-and-regulations/.

Figure 4.5 The artic flora is beautiful but vulnerable. Photos: Morten Rasch.

Figure 4.6 Avoid bringing invasive species with you. Credit: The Norwegian Institute for Nature Research, www.stoparcticaliens.com.

Invasive species

When you travel to the Arctic, you should be aware not to bring any invasive species with you. The term 'invasive species' refers to species that are not native to a given ecosystem. Invasive species may spread in their new environment, affect native species abundances and ecosystem functions, and potentially become a threat to the local biodiversity. There are currently few invasive species in the Arctic, but more are expected with Climate Change and increased human activity.

Spreading of invasive species can happen due to an intentional or unintentional escape, release, dissemination or placement of species into the arctic ecosystems due to human activity.

When travelling to the Arctic you may accidentally carry small creatures, plants or plant seeds, bacteria and viruses with you. You should prevent bringing non-native species with you and your equipment, when travelling to research stations or field camps.

Environmental considerations

- Brush, hoover and wash your bags, clothes, shoes and equipment before leaving home.
- If you bring fishing equipment, this should be disinfected by means of drying and heating, freezing or chemical treatment.
- Be aware that you might also bring invasive species with you out of the Arctic. You should therefore also be careful with cleaning everything before your homebound travel.
- Report a pest and spread the word of caution to other scientists.

Local communities

Many inhabitants of the Arctic live in a close relation with nature, giving them extensive knowledge and experience of relevance to both general scientific issues, environmental issues and working conditions in the natural environment. Local knowledge of the environment/nature, local weather conditions, waters, local flora and fauna, ice conditions, glaciers and icebergs, dangerous terrain, wildlife, etc., can be very important for your scientific achievements and for the safe conduction of your fieldwork. We recommend that you tap into this knowledge during your fieldwork planning and accomplishment, either by involving locals in your project or by seeking advice from locals once in the field. This can both be knowledge of direct relevance to your research topics but it can also be knowledge of relevance to safety aspects and environmental concerns.

All scientists who visit the Arctic and northern alpine and boreal zones must respect local communities, their culture, traditions, everyday life and knowledge. Part of this responsibility includes adhering to ethical standards for working with or alongside local communities, including:

- Be sensitive about your engagement with local people. They are often very open and willing to share information but may also experience 'researcher fatigue'.
- Be sensitive to local culture and traditions. Respect local activities and avoid disturbing hunting/fishing activities and sites of local importance.
- Be sure to obtain consent from local people if you intend to use their information in publications, and give your informant proper credit.
- Remember reciprocity of research benefits by sharing your knowledge with the local community.
- Be prepared to pay for the services provided by locals (e.g. field assistants, guides, translation services and transport assistance).

Consult your local contact (the station manager, a local inhabitant that you have communicated with or similar) to find out what is the best way of engaging with the local community and how to establish contact.

Figure 4.7 Reindeer-herder on Yamal Peninsula, Russia. Photo: Alexandr Sokolov.

5 After the fieldwork

Photo: Morten Rasch

Once you are back home, it is always a good idea to evaluate the different aspects of your fieldwork. Such an evaluation should also include environmental impact aspects. You may have been aware of the potential environmental aspects already during the planning of your fieldwork, but once you have accomplished your fieldwork you may have discovered new aspects that you should consider in future fieldwork planning efforts. This can relate to available travel opportunities, local conditions at the research station, local conditions in the field and in relation to the specific procedures relating to the scientific part of your fieldwork. As part of such an evaluation, you could ask yourself questions like:

1) Did you travel in the most sustainable way possible?
2) Did you ship your cargo in the most sustainable way possible?
3) Could you have reduced your environmental impact at the research station by being better prepared? In what way?
4) Could you have reduced your environmental impact in the field by being better prepared? In what way?
5) Were there any occasions at which you caused or easily could have caused environmental damage? How can you prevent getting in a situation like that again in the future?

If you have already undertaken fieldwork when reading this book, it might be a good idea to do an evaluation of this before you start using the guidebook for the planning of a new fieldwork activity. It is good to have your previous experiences in recent mind when you start planning for something new.

It is also a good idea, while the fieldwork is still fresh in mind, to make a list of identified smart ways to reduce your environmental impact during your future fieldwork. You can write this list on page 43 in this guidebook, to make sure that you have it easy at hand next time you are going to plan and conduct a field work in the North.

Personal notes on smart ways to reduce environmental impacts:

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About INTERACT

INTERACT – International Network for Terrestrial Research and Monitoring in the Arctic is a network of more than 85 research stations located in the Arctic and adjacent boreal and alpine areas. The main objective of INTERACT is to provide a circum-arctic platform for identifying, understanding, predicting and responding to current environmental changes that take place in the Arctic and neighbouring areas. The INTERACT stations host over 18,000 research visits annually, facilitating top-level research and monitoring programmes within a wide range of scientific disciplines from natural sciences to the human dimension.

www.eu-interact.org

Other INTERACT books of relevance to arctic fieldwork.
Available on www.eu-interact.org

INTERACT Fieldwork Planning Handbook
The INTERACT Fieldwork Planning Handbook covers all aspects of fieldwork from capturing the idea through the actual fieldwork to getting safely back home with samples and data to wrap up the project. A particular focus is put on the planning aspects until you venture into the field and on the safety aspects when working at INTERACT stations or in the field.

INTERACT Practical Field Guide
The INTERACT Practical Field Guide contains information on best practices and safety aspects in relation to fieldwork in the Arctic. The book was developed as a handy tool to be used both during the preparation of your fieldwork and particularly for use while in the field.

INTERACT Fieldwork Communication and Navigation
The INTERACT Fieldwork Communication and Navigation is a guidebook helping you to choose between and use different communication and navigation devices during your fieldwork.

INTERACT Station Catalogue
The INTERACT Station Catalogue (Third Edition, 2020) contains descriptions of 87 INTERACT stations, including ownership, location, surrounding landscape, history, data availability, local communities, access, general climate statistics and contact information.

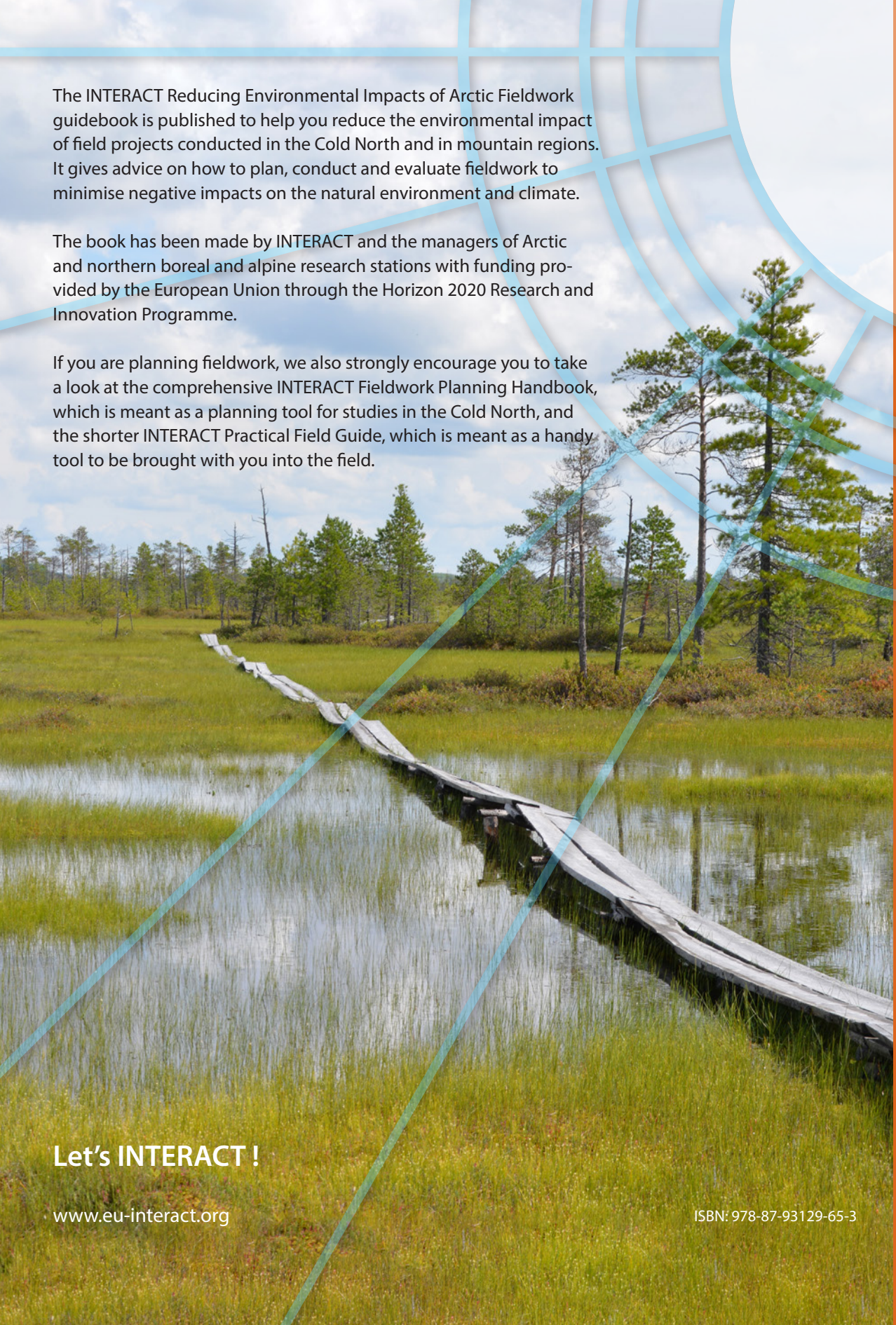
INTERACT stations can also be explored in **INTERACT GIS** (https://interact-gis.org/), where you can filter stations according to specific environmental features when looking for ideal stations to conduct your research. Here you can also explore information about science activities at the individual stations and find contact information.

The **INTERACT Permits and Regulations for Arctic Fieldwork** platform on the INTERACT homepage contains information for each of the eight Arctic Council member countries on regulations to be followed and permits to be applied for when you plan to do fieldwork in the Arctic.

The INTERACT Reducing Environmental Impacts of Arctic Fieldwork guidebook is published to help you reduce the environmental impact of field projects conducted in the Cold North and in mountain regions. It gives advice on how to plan, conduct and evaluate fieldwork to minimise negative impacts on the natural environment and climate.

The book has been made by INTERACT and the managers of Arctic and northern boreal and alpine research stations with funding provided by the European Union through the Horizon 2020 Research and Innovation Programme.

If you are planning fieldwork, we also strongly encourage you to take a look at the comprehensive INTERACT Fieldwork Planning Handbook, which is meant as a planning tool for studies in the Cold North, and the shorter INTERACT Practical Field Guide, which is meant as a handy tool to be brought with you into the field.



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