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NATURE-BASED SOLUTIONS IN INDUSTRIAL ENVIRONMENTAL MONITORING PROGRAMMES

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ABSTRACT

Requirements for performing environmental self-monitoring (ESM) of various installations are set in the Russian legislation. However, large industrial plants often need to develop and run Industrial Environmental Monitoring (IEM) Programmes not at source but within the zone of influence, which in Russia is defined as the area at the boundaries of which concentrations of contaminants emitted by the pollution source reach 5 % of respective maximum allowable concentrations (ambient air quality standards). IEMP objectives must be set considering valuable ecosystem services of the region while possible ways to implement of Nature-Based Solutions (NBS). Ecosystem services should be regarded as the benefits that people receive from ecosystems, such as food, fuel, clean air, fresh water, flood and disease control and crop pollination, as well as opportunities for cultural, spiritual and recreational experiences. Indicators of ecosystem services are critical for assessing the state of the ecosystems. The choice of potential ecosystem services and their indicators is determined by the IEMP objective sand the availability of data from various sources. Indicators applied should have physical meaning and be measurable, so that any changes in the indicators will clearly identify changes in the certain ecosystem service. The emphasis on NBS application is very important, because they are planned for implementation at a considerable distance from the installation, even within recreational areas and protected landscapes.

Keywords: Best Available Techniques, environmental self-monitoring, industrial environmental monitoring, Nature-Based Solutions, ecosystem services

INTRODUCTION

Two inter-related instruments – environmental self-monitoring (often called industrial environmental control) and environmental monitoring in impact areas (or industrial environmental monitoring) are used in Russian-speaking countries to obtain the necessary information, to assess it and to forecast expected changes in the environmental aspects and impacts and to set a system of measures needed to comply with the environmental legislation.

The Russian Federal Law on Environmental Protection provides for mandatory environmental self-monitoring both at larger polluters – installations of Category I (similar to Integrated Pollution Prevention Control, IPPC installations in the European Union) and at smaller installations of Categories II or III. Though there are no specific legislative provisions, IPPC installations causing significant negative environmental impacts often also need to carry out industrial environmental monitoring programmes within the boundaries of so-called zones of influence – the areas at the boundaries of

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which concentrations of contaminants emitted by the pollution source reach 5 % of respective ambient air quality standards or maximum allowable concentrations (Fig. 1) [1].

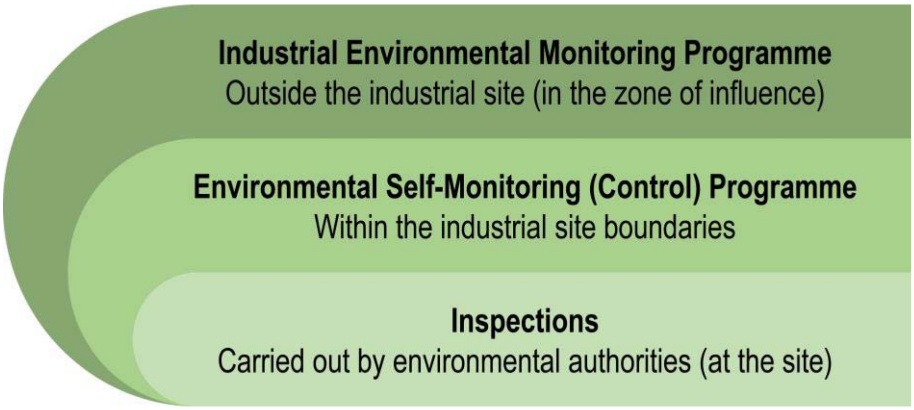

Figure 1. Industrial Environmental Monitoring and Environmental Self-Monitoring (Control) Programmes

Unlike for the ESM programme, there are no clear requirements in place as to the definition of monitoring parameters, sites or frequency for the development of an industrial environmental monitoring programmes, which forms difficulties for the IEMP developers often resulting in an "empty", declaratory IEMP unable to produce meaningful information. This paper considers opportunities and barriers for the development and implementation of inter-related environmental self-monitoring and industrial environmental monitoring programmes by the Russian IPPC installations.

BEST ENVIRONMENTAL PRACTICES AND NATURE-BASED SOLUTIONS

In 2011, the European Commission specified a list of priority economic sectors for which Best Environmental Practices (BEP) were to be developed based on the following criteria: the sector's environmental impact; the sector's level of implementation of the **Eco-Management and Audit Scheme** (EMAS); and the potential for minimising the negative anthropogenic impact along the value chain [2, 3].

We believe that in the development of an enterprise-level IEMP, the following aspects should be taken into consideration:

– IEMP objectives should be defined through the potential ecosystem services provided by the region where the installation is located;

– possible ways to reduce the load on the ecosystems should be defined through the implementation of Nature-Based Solutions.

The concept of Nature-Based Solutions (NBS) seeks to conserve, restore or improve natural ecosystems and ecosystem services simultaneously delivering benefits for humans (such as managing flood flows, reducing soil erosion, enhancing water resources) as well as providing food and fuel [4, 5, 6].

Ecosystem services are defined as benefits that humans receive from ecosystems, such as food, fuel, clean air, fresh water, flood control, disease control, and pollination of crops, as well as opportunities for cultural, spiritual, and recreational experiences [4, 7]. Human survival and well-being are entirely dependent on the ecosystem services and, therefore, on the condition of the respective ecosystems. Ecosystem service indicators are critical for assessing the ecosystem condition, which allows defining strategies or other necessary interventions for their better management, including the development of an IEMP. However, despite a growing need in those, it is often difficult to develop reliable indicators.

The choice of potential ecosystem services and their indicators for assessment depends on the respective strategic goals and availability of data from various sources, such as the enterprise's ESM programme, data of the state environmental monitoring as provided by the Federal Hydrometeorology Service, etc. Importantly, any indicators to be used should be physically meaningful and measurable, for in that case any variation in the measurable indicators will clearly identify the variation in the respective ecosystem service (Fig. 2). The lack of reliable data would result in a high level of uncertainty in the assessment of the ecosystem services which would affect the selection of goals.

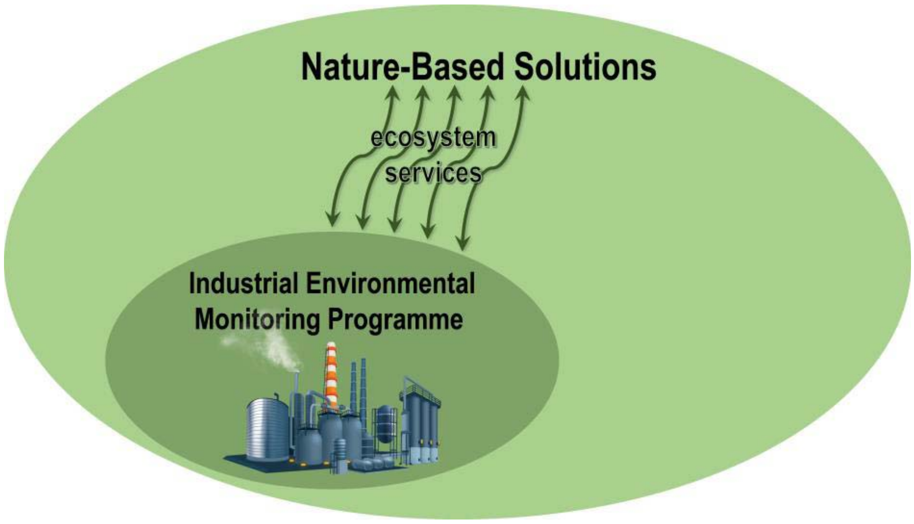

Figure 2. Industrial Environmental Monitoring Programmes and Nature-Based Solutions

To obtain reliable data and harmonise the views of the stakeholders, IEMP should be conducted through a public dialogue (an example of which is the IEMP and the implementation of Nature-Based Solutions in the Russian Arctic by Mondi-Syktyvkar JSC, a Category I (IPPC) pulp and paper plant [8].

Potential ecosystem services can also be assessed by means of an environmental risk assessment model describing how an installation’s impact can affect the components of the environment.

The emphasis on NBS solutions is particularly important, as they are planned for implementation not on the industrial site but at a significant distance from it, including recreational and even protected areas. Therefore, installing, e.g., a local waste treatment plant on the watercourse could lead to an increased negative impact on the ecosystem. It is understood that Nature-Based Solutions should be first implemented for significant environmental aspects, namely those selected through the ecosystem service assessment.

The NBS concept emerged as an alternative to conventional engineering solutions and is best viewed as an umbrella term encompassing many different approaches in different areas which share a common focus on ecosystem services and address societal issues. The NBS approaches can be broken up as follows:

– approaches to ecosystem restoration (e.g., restoration of forest landscapes);

– ecosystem approaches to addressing specific problems (e.g., adaptation, mitigation of natural disasters);

– infrastructure approaches (e.g., “green” infrastructure approaches);

– ecosystem-based management (e.g., integrated water-resources management);

– ecosystem-based management (e.g., management of protected areas).

Basically, the International Union for Conservation of Nature (IUCN) recommends to classify NBS into the following three types:

– type 1: solutions that would make a better use of existing natural or protected ecosystems;

– type 2: solutions based on the furthering of the sustainable development principles and procedures for the management or restoration of ecosystems;

– type 3: solutions that would involve creation of new ecosystems (e.g., green buildings, green roofs).

Among the multitude of NBSs, we would like to consider a cluster of solutions which intend to mitigate the climate change and can be included in the IEMPs of large enterprises.

In this context, an NBS can make a significant contribution to the climate action by preventing degradation and loss of natural ecosystems. Deforestation causes an additional 4.4 Gt/year in carbon dioxide (measured in CO_2-eq) emissions, which is approximately equal to 12 % of the total anthropogenic emissions of greenhouse gases. Preventing these emissions through better conservation and management of land resources, including forest restoration, would make a significant contribution to the mitigation of climate change [9].

For industrial installations, it is desirable to develop unified sector-wide approaches based on the necessary and sufficient data obtained. It seems advisable to include a well-organised voluntary environmental monitoring system into the programmes of Best Environmental Practices (BEP) for major polluters, first of all, functioning in the vulnerable Arctic region [3, 8, 10].

Obviously, these principles are under consideration by most sectors of the economy while their practical application is put off; however, over the past five years, large companies, especially in industries such as mining, metals, chemicals, and petrochemicals, have begun to develop and implement long-term environmental strategies on their own. Therefore, implementation of a long-term environmental action programme could serve as an evidence of the company’s responsible behaviour, with different priority application areas selected for the programme depending on the production specifics.

There are known cases of environmental programmes being successfully implemented by enterprises in various industries. Extractive industries whose operation involves significant damage to land have pioneered such programmes.

Reclamation of soils disturbed by oil and gas production is an example. The problem there is that oil and gas deposits are mainly located in a severely continental climate. For instance, the Khanty-Mansi Autonomous Okrug (Region) taking up the greater part of the West Siberian Oil and Gas Province, one of the world's largest oil-producing regions, accounts for over 55 % of Russia's oil output and over 6 % of the global oil output. Its severely continental climate along with a short vegetative season (120-130 days) make reclamation of disturbed soils a complicated endeavour.

Nevertheless, companies such as JSC SamotlorNeftegaz (hydrocarbon exploration sector) have successfully implemented reclamation programmes based on a combination of engineering techniques and biological approaches to reclamation on the basis of the NBS. For instance, drilling sludge produced during well drilling and placed in sludge pits is processed into ground serving as a soil material, with its further use in situ for reclamation of sludge pits. The main principle proposed for land reclamation is to stimulate natural processes of soil self-cleaning using activities such as soil loosening and creation of artificial microrelief, dressing of peat, lime, mineral fertilizers, and oil-oxidizing microorganisms, sowing of improver grass, and forest transplanting.

To accelerate the turf formation, restore and form the root layer and to enrich the latter with organic matter, grass mixtures of several grass species, including annual and perennial, cereals and legumes, are sown at the biological stage [11]. Preference is given to grass mixtures following the combination of plants in the natural community.

For the reclamation of swamps, including transitional swamps, it is recommended to use smallreed *(Calamagrostis langsdorffii (Link) Trin),* common cottongrass *(Eriophorum angustifolium Honck., nom. cons*), beaked sedge *(Carex rostrata Stokes*), *C. rhynchophysa C.A. Mey*., acute sedge *(C. acuta L*.), and, for heavily watered areas, water arum *(Calla palustris L.*) and broadleaf cattail *(Typha latifolia L*.). Species such as American slough grass *(Beckmannia syzigachne (Steud. Fern.*), European slough grass *(B. eruciformis (L.) Host*), smallreed *(Calamagrostis langsdorffii (Link) Trin)* are recommended for the reclamation of the floodplain grass marshes, while the following species are recommended for phytomelioration on the highland moors: smallreed *(Calamagrostis langsdorffii (Link) Trin),* fowl bluegrass *(Poa palustris L*.). bluegrass (*P. turfosa Litv*.), black bent *(Agrostis gigantea Roth).*

In the reclamation of sludge pits, phytomelioration is followed with forest reclamation, a technique aimed at accelerating the process of natural formation of productive and biologically diverse swamp forest ecosystems. In doing so, different species of willow (*Salix*) are set out around the perimeter and on the surface of the sludge pits, which not only helps dry up the sludge pits and strengthen the bund walls against the exposure to water erosion and blowing erosion but, most importantly, generates a forest litter enabling the recovery of native woody plants and formation of soil featuring all the characteristics of soils in the respective region. The willow is the most efficacious phytomeliorating species for sand fixation, being eurytopic and able to serve as either a principal species or a species preparing conditions for successful vegetation of indigenous species. Thus, NBS-based techniques of phytomelioration and forest reclamation allow to effectively restore swamp forest ecosystems on lands disturbed by oil or gas production.

Environmental programmes of metallurgical enterprises are of interest, too. For example, the long-term operation of the Karabashskiy Copper-Smelting Plant during

1933 to 1989 resulted in the large areas of land being subjected to uncontrolled industrial impact. The smelter had a currently decommissioned tailings pond designed for the storage of dry pyrrhotite tailings of the beneficiating plant. The company developed a programme to reclaim the disturbed area, a zone of anthropogenic landscape where the natural soil and humus had been completely destroyed, based on the principles of circular economy (with using the company's own waste for the reclamation) and the best available techniques according to the Russian BREF 17-2016 “Disposal of production and consumption waste” [12], with a focus on restoration of biodiversity and NBS. The company's own waste – sand and gypsum – was used to fill the surface of the tailings pond before a fertile soil layer was put on and annual and perennial grass species, mainly cereals, were sown. The programme implementation is expected to result in the restoration of the landscape and plant community.

Similar NBS are used by enterprises also for watered sludge reservoirs. At JSC Russian Copper Company, a large-scale programme of elimination of the accumulated environmental damage is under way, with a view to decommissioning the sludge reservoir and reclaiming the disturbed land in the city of Kyshtym, Chelyabinsk region, Russia. The sludge reservoir with an area of over 28 hectares designed to receive settled, purified wastewater is located on the woodlands in the Kyshtym forest district. The bottom deposits in the sludge reservoir are contaminated with copper sulphides and nickel sulphides. As the company implemented measures to modernise its technology allowing to abandon the use of the sludge reservoir, it was possible to employ engineering solutions for neutralising the sludge stock and contaminated sediment layer at the bottom of the structure while using the sludge reservoir as a storage lagoon for settled and purified wastewater to be used in-house for process purposes. To that end, insulating ledge rock was applied on the bottom sediments which stopped the secondary contamination of water with heavy metals.

Two of the above programmes aimed at restoring the disturbed phytocoenosis, including forest replantation, while the third one aimed at restoring a water body to be gradually integrated back into the natural ecosystem.

Reverting to the enterprise-level environmental monitoring programmes, it should be emphasised that once the reclamation and restoration of the ecosystems have been completed, the enterprises do not remove the respective objects from their monitoring programmes, instead continuing to monitor the progress of ecosystem restoration and taking additional measures, if necessary.

Therefore, it is important to identify the key NBS parameters to be taken into consideration in the monitoring programmes; such parameters should be underpinned with reliable scientific knowledge, allowing for the use of clear and reliable criteria and easily measurable indicators; the number of the parameters should be limited. The list of such parameters can include environmental complexity, i.e., measures conducive to increased complexity of the ecosystem and restoration of biodiversity; long-term stability; and societal benefits.

CONCLUSION

In recent years, Russian companies have increasingly focused on action for environmental protection and sustainable development goals, based on the best environmental practices including Nature-Based Solutions.

Such activities of Russian companies enjoy support from the state: the Ministry for Natural Resources and Environment is involved in the development of a national platform “Business and Biodiversity”, while the Ministry for Industry and Trade and the Ministry for Economic Development are working on the recommendations on the preparation of regional and sectoral climate change adaptation plans. Nature-Based Solutions are considered to be a valuable adaptation instrument though in most cases technocratic solutions still dominate. Still, the Green Taxonomy for ESG (Environmental Social Governance) investments [13] which is being developed in Russia, opens opportunities for financing both technological projects (for instance, those aimed at implementing best available and emerging techniques – in accordance with IPPC terminology) and “green” projects aiming at the restoration of damaged areas applying NBS.

As far as IEMP are concerned, businesses expect to receive clearer and more concrete proposals and recommendations from the above authorities for developing their own programmes of environmental monitoring and ecosystem restoration based on Best Environmental Practices and Nature-Based Solutions.

Importantly, large Russian businesses are increasingly aware of the global ecosystem problems and issues underlying the 2030 Agenda, and their motivation has been evolving from the funding of one-off programmes to the recognition of economic and other long-term benefits to be gained by the business itself from investment in biodiversity and environment.

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