INTERRELATEDNESS OF BEST AVAILABLE TECHNIQUES AND BEST ENVIRONMENTAL PRACTICES: A MUNICIPAL WASTEWATER TREATMENT CASE

Assoc. Prof. Dr. Irina Tikhonova[1]

Prof. Dr. Sci. Tatiana Guseva[2]

Dr. Svetlana Panova[3]

[1] Dmitry Mendeleev University of Chemical Technology of Russia, **Russian Federation**
[2] Research Institute 'Environmental Industrial Policy Centre', **Russian Federation**
[3] Independent expert, **Russian Federation**

ABSTRACT

The concept of Best Available Techniques (BAT) is the basis for granting Integrated Environmental Permits (IEP) to industrial installations. In Russia, BAT is used along with Best Environmental Practices (BEP) concept to promote resource efficiency solutions and to motivate managers to collaborate with local stakeholders in the field of environmentally sound activities. One of the sectors modernised in accordance with the principles of BAT is municipal wastewater treatment (MWWT). In 2020, the Russian Reference Document (BREF) on BAT for MWWT Plants was recommended to the governors of BRICS cities as the basis for the improvement of MWWT performance as well as for the better conservation of fresh water bodies. BAT-Associated Environmental Performance Levels set by the MWWT BREF are used as the reference conditions for modernising existing facilities since 2019. A case of the Podkumok River, flowing through the recreational area of the Caucasus Mineral Waters is considered. The article analyses the Environmental Performance Enhancement Programme (EPEP) worked out by the Pyatigorsk MWWT plant as a starting point for the development of the public dialogue in the field of the restoration of the Podkumok River valley ecosystem services and provides practical recommendations for managers, municipal governments and educational establishments.

Keywords: Best Available Techniques, Best Environmental Practices, ecosystem services, Nature-based Solutions, wastewater treatment, pollution prevention and control

INTRODUCTION

The concept of Best Available Techniques (BAT) has been widely adopted across the world as the basis for the enhancement of environmental performance and resource efficiency of key industrial sectors for over 50 years [1]. Along with the 'classical'

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European approach, focused on applying BAT for setting conditions of Integrated Environmental Permits (IEP) [2], BAT is also referenced in various international conventions, standards, and practical guidance documents, not necessarily dealing with IEP or other permits [3]. In most regulatory frameworks, BAT still has an obligatory character. At the same time, Best Environmental Practices (BEP), also referred to as Best Environmental Management Practices, are often considered as voluntary activities allowing to further improve environmental performance and expand the area of an organisation's responsibility [4].

The reason that the Environmental, Social and Governance (ESG) criteria have become more and more influential in various countries and regions is because BAT, BEP and other opportunities to objectively assess the value of environmental compliance and 'beyond compliance' activities attract the attention of industry, investors, academia, non-governmental organisations and other stakeholders [5]. Transparent BAT criteria are often undervalued and such terms as 'environmentally friendly' or 'green' remain in use as characteristics of technologies, services or products not requiring any quantitative assessment [6].

In this paper, we consider the interrelatedness of a compulsory BAT-based Environmental Performance Enhancement Programme (EPEP) of a wastewater treatment company and the voluntary BEP-based initiatives of local stakeholders. The case is rather specific as it analyses the area of Pyatigorsk Spa Resort in the Northern Caucasus, Russia. At the same time, the case is typical because the assessed interrelationship between Best Available Techniques and Best Environmental Practices, can be implemented elsewhere.

METHODS

To study the interrelatedness of BAT and BEP, methods of analysis and synthesis typical of environmental research were applied. This combination of analytical methods allowed to implement a systematic approach to the (1) environmental industrial policy at the federal and regional levels on one side and (2) environmentally sound practices of various organisations on the other. The industrial environmental policy aims to support the improvement of environmental performances and resource efficiency of economic actors by setting obligatory conditions (BAT) and supporting ('green') enterprises. Development of voluntary BEP requires the collaboration of key stakeholders and needs to be based on clear (preferably – quantitative) criteria. In this article these two methods, and the findings, are analysed and reviewed for the purposes of identifying practical recommendations aimed at building public dialogue, improving environmental practices and developing collaboration of key local stakeholders.

RESULTS

The Northern Caucasus Mineral Water Spa area (a part of the Stavropol' region of Russia) embraces three major cities – Yessentuki, Kislovodsk and Pyatigorsk with the population of about 400,000 inhabitants (Fig. 1).

Figure 1. A view of Pyatigorsk

The region has been gradually developed since the 19th century; its mountains and mineral waters, abundant green areas and historical sites attract visitors from many regions. Every year over 500,000 tourists visit the Spa Resorts.

Pyatigorsk Wastewater Treatment Plant (WWTP) is located eastwards the resort area (Fig. 2) and processes both municipal and pre-treated industrial wastewater. WWTP was commissioned in 1986 and treats about 170,000 m^3/day of municipal wastewater. The receiving water body is the Podkumok River. According to the BAT-related legislation passed in 2014, Russian municipal wastewater plants must ensure compliance with the requirements of BAT-Associated Emission Limit Values (BAT-AELs) set in the sectoral Reference Document on Best Available Techniques (BREF 10-2019) [7]. Installations failed to complying with BAT-AELs must develop EPEPs and implement them within 7 years [3]. Each EPEP becomes a significant part of the IEP.

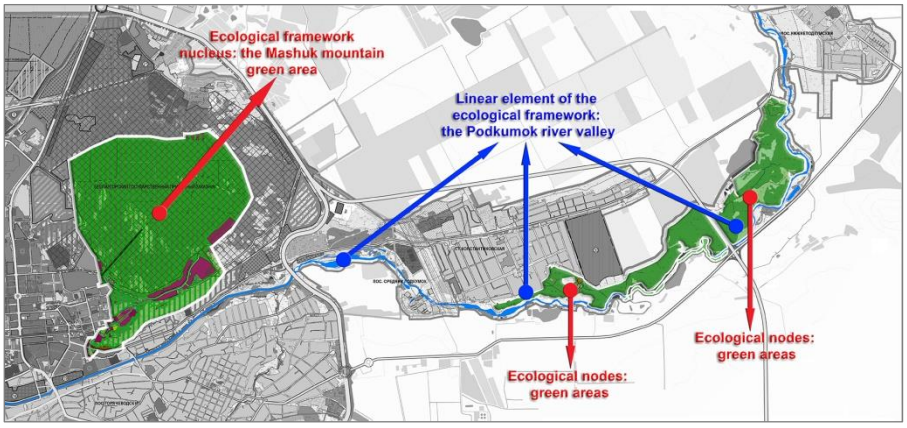

Figure 2. The city of Pyatigorsk schematic map

In 2021, Pyatigorsk WWTP developed an EPEP aimed at the reduction of phosphorus and nitrogen emissions. At the same time, WWTP capacity had to be increased up to 250,000 m^3/day. Specific emissions of nutrients were to be reduced as follows: $P(PO_4)$ – by 30 %, $N(NO_3)$ – by 46.5 %. It was expected that the implementation of the EPEP would ensure Pyatigorsk WWTP complied with the environmental legislation requirements and resulted in the stipulated environmental load decrease (see Table 1). In 2022, Pyatigorsk WWTP plans to apply for the IEP, and the Northern Caucasus unit of

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the Federal Supervisory Natural Resources Management Service (the key environmental authority) will begin monitoring the EPEP implementation.

Table 1. Environmental Performance Enhancement Programme of Pyatigorsk Wastewater Treatment Plant: key characteristics

Parameters	Current concentrations of nutrients in treated wastewater, mg/dm^3	BAT-AELs treated wastewater (set in BREF 10-2019), mg/dm^3	Increase of WWTP capacity, thousand m^3 per day	Reduction of emissions of nutrients, tonnes/year
$N(NO_3)$	12.84	9.0	80	1.25
$P(PO_4)$	1.31	0.7		20.04

In 2022, the EPEP was reviewed and approved by the Interdepartmental Commission. Pyatigorsk WWTP began implementing the EPEP. The Research Institute 'Environmental Industrial Policy Centre' has also commenced collaboration with the University of Pyatigorsk for the purposes of identifying and developing opportunities for linking the BAT-related programme of the WWTP and the BEP-based activities of local stakeholders.

DISCUSSION

The Podkumok River flows through Pyatigorsk and is a natural boundary between the northern and southern parts of the city. Luxurious residential districts and spa resorts are located on the left bank of the river (Fig. 2). There is an abundance of nearby attractions such as the picturesque Mashuk mountain, vast natural parks, and mineral water wells. The river also provides water for cooling and irrigation, it is suitable for recreational fishing, and it can have cultural and aesthetic value [8, 9]. The Podkumok River contributes to the need of an additional wastewater treatment facilities and supports terrestrial ecosystems suitable for housing, recreation, and wildlife habitats.

Nature-based Solutions (NbS) were defined by the International Union for Conservation of Nature (IUCN) in 2016 as "actions to protect, sustainably manage and restore natural or modified ecosystems, which address societal challenges effectively and adaptively, while simultaneously providing human well-being and biodiversity benefits" [10].

The European Commission provides an alternative perspective on NbS and defines them as solutions that "aim to help societies address a variety of environmental, social and economic challenges in sustainable ways. They are actions which are inspired by, supported by or copied from nature". This concept has a "larger focus on urban ecosystems, due to the high percentage of the population of Europe that lives in cities and the need to address challenges such as human health, climate change and degradation of natural capital" [11].

The Global NbS Standard [10] consists of 8 key criteria which could provide a valuable support to various users while assessing, identifying and enabling design of NbS:

1) NbS effectively address societal challenges;
2) Design of NbS is informed by scale;
3) NbS result in a net gain to biodiversity and ecosystem integrity (this is the primary intention of forming the ecological framework);

4) NbS are economically viable (most measures will have a low-cost character);
5) NbS are based on inclusive, transparent and empowering governance processes (this will be achieved via the public dialogue and involvement of key stakeholders);
6) NbS equitably balance trade-offs between achievement of their primary goal(s) and the continued provision of multiple benefits (recreational and educational benefits first of all);
7) NbS are managed adaptively, based on evidence (this 'green' case-study is the first planning and management step);
8) NbS are sustainable and mainstreamed within an appropriate jurisdictional context (compliance with the federal and regional legislation is guaranteed).

Considering these definitions and criteria, we believe that the development and implementation of small-scale NbS involving the Pyatigorsk City Administration, Pyatigorsk University, local schools and WWTP, could help to both attract attention of stakeholders to the Podkumok River ecosystem services and set the structure of the territorial ecological framework.

Pyatigorsk is a spa resort and an industrially developed city with over 300 large and medium enterprises and approximately 1,200 small enterprises, engaged in the food, pharmaceutical, construction materials, leather, fur and footwear sectors [12]. Such food industries as Pyatigorsk Milk and Meet Factories are the largest industries providing city inhabitants and numerous tourists with fresh local products. From the environmental point of view, they consume a lot of fresh water while their emissions contribute significantly towards the overall environmental load. At the same time, arable land and animal farms surrounding the city contribute negatively to soils and ground water.

For the past 25 years, population density has grown significantly and has reached 2,105 people per km^2 in Pyatigorsk, and over 150 persons per km^2 in the area of the Mineral Water Spa Resorts (compared to 42 people per km^2 in the Stavropol' region on average) [12]. This has led to the rapid growth of negative environmental impacts, in some cases, caused by illegal construction activities within the green areas surrounding the city. At the same time, a growing tourist flow is responsible for high depletion of balneological resources and the degradation of resort parks and picturesque landscapes.

In general, current development of recreational activities and services in Pyatigorsk can be described as chaotic and does not consider the natural capital and ecosystem services of this unique territory. To mitigate this, the Environmental Performance Enhancement Programme developed by the Pyatigorsk WWTP should be considered both in terms of the implementation of BAT and the improvement of the environmental situation in the Pudkumok River catchment.

In Pyatigorsk, an ecological framework for the Podkumok River and adjacent area, based on the NbS principles shall be developed. This framework should consist of several parts each with specific regimes (conditions) of their use. We believe that the framework could exist as a whole system of interacting elements helping to mitigate negative impacts on the landscape and prevent its degradation. The ecological framework is an instrument which has to be recognised by the modern decision-making system at the regional and city levels. Involvement of the Pyatigorsk city government along with stakeholders representing local schools and universities will help to balance economic, social and

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environmental development priorities. It is hoped, that similar to the leading wastewater treatment companies, Pyatigorsk WWTP will participate in educational and awareness activities arranging for 'open days', environmental field trips and small-case hydrochemistry and hydrobiology lessons for university students [13].

The main role of the ecological framework is conserving and supporting natural processes with the greatest impact on the sustainability of local landscapes, ecosystems, and biodiversity. In addition, the ecological framework should provide for flexible and different natural systems. The framework developed in the city should serve for (1) environmental protection; (2) habitat forming; and (3) recreation.

The structure of the river network ensures the canalised movement of living matter over the land surface, plays a role in the ecological infrastructure of the region, and simultaneously maintains the heterogeneity and discreteness, by delimiting river valleys with barriers. The fulfilment of the ecological function performed by the river network is especially effective when it provides for the interaction with intact territories outside the city. This ensures the continuity of the living cover, maintaining diversity and the possibility of exchanging components of natural and urban areas. Thus, a river that runs through a valley, plays the role of an ecological corridor that maintains the integrity of the biosphere at the local level. This position corresponds with the key principles of rivers restoration published by the international teams of researchers in 2016 and 2020 [14, 15].

Since habitat fragmentation is one of the most serious threats to biodiversity, it is evident that linkages between reserves should become the main principle for designing the ecological framework. The presence of a linear element (the river valley) connecting the basic reserves (in our case – the Mashuk mountain nucleus with the green sites serving as the framework nodes is one of the main conditions for the functionality of the ecological framework (see Fig. 2-3).

Figure 3. Views of the Podkumok river

To assess opportunities for developing the Podkumok river-based ecological framework, preliminary studies are being conducted. These studies are determining the degree of disturbance of the catchment areas and key elements of the ecological framework. Such 'classification' of the Podkumok River catchment into the set of areas with different land use regimes will help to form economic instruments and the overall management system necessary for the sustainable development of the ecological framework.

So far, based on the first field studies and discussions with the relevant local stakeholders, three priority directions of the river network in Pyatigorsk can be suggested, namely:

1) managing Pyatigorsk natural complex should be focused on the Podkumok River valley
2) the forming of a psychologically comfortable urban environment with attractive recreational sites located close to the city
3) the development of educational and awareness activities (ecological paths, thematic excursions, outdoors lessons, etc.)

Small-scale restoration projects are already being planned and implemented in accordance with NbS criteria. The proposals and developments originate from discussions with Pyatigorsk City Administration, WWTP management and educational establishments. The development of the ecological framework addresses societal challenges (criteria 1, 5). The Environmental Performance Enhancement Programme aimed at reducing discharges of nutrients into the river, provided the initial impulse to the ecological framework initiative. Special conservation measures and linkages between the framework nucleus and nodes are aimed at protecting biodiversity and improving ecosystem integrity (criteria 3). Initial educational and recreational benefits will be gained while achieving biodiversity-related benefits, will require more time (criteria 6). The first ecological path located at the boundaries of the city of Pyatigorsk (Konstantinovskaya settlement) is being designed jointly by the Pyatigorsk University and local secondary school. Gradual development of the initiative is organised in the close collaboration with Pyatigorsk City Administration, federal authorities, local educational establishments and environmental non-governmental organisations in accordance with applicable legislative requirements (criteria 4 and 8). This green case is the first step in providing the evidence of benefits, which can be gained as a result of small-scale (and low-cost) measures aimed at formation of Pyatigorsk ecological framework.

CONCLUSION

The interrelatedness of Best Available Techniques and Best Environmental Practices is analysed using the case of Pyatigorsk city. It is demonstrated that designed Wastewater Treatment Plants in compliance with the Environmental Performance Enhancement Programme meets the requirements of BAT-related legislation and forms the necessary background for starting public dialogue in the field of BEP and NbS, targeted at restoring ecosystem services of the Podkumok River. It is envisaged that the EPEP implementation would simultaneously reduce the environmental load on the Podkumok River, allowing the growing flow of municipal and industrial wastewater. In 2021-2022, an open discussion of the draft EPEP helped attract attention of local stakeholders and federal authorities to this case.

Initial assessments allowed to suggest forming an ecological framework helping to manage the unique natural complex of Pyatigorsk Spa Resort area, establish a network of small-scale recreational zones in the Podkumok River valley, and strengthen educational and awareness raising activities of local schools, universities and environmental non-governmental organisations.

Recognition of the importance of the Podkumok river ecosystem services are considered to be the interface between ecosystems and human well-being and it will help to improve the state and capacity of the river ecosystem and provide additional benefits for local inhabitants and numerous tourists visiting the Northern Caucasus Mineral Water Spa Resorts area.

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