NORWEGIAN ENVIRONMENT AGENCY

Appendix B
Customer needs and requirements for the idea sketch

Automatic environmental monitoring using environmental-DNA

This is a translation of the official document written in Norwegian: "*Vedlegg B*".

Introduction

The Norwegian Environment Agency aims to improve and increase the efficiency of our environmental monitoring. We therefore aim to develop automatic environmental monitoring using environmental DNA.

In recent years, environmental DNA has proven to be well suited to streamline and improve environmental monitoring. In particular, the collection of environmental samples is considerably simplified in that a larger number of species can be registered in one water sample. Aquatic environment is particularly well suited for this method. One of the challenges, but at the same time the potential of using environmental DNA for monitoring, is to establish automatic measurements.

There is both national and an internationally, a need and a market for technology addressing the need of early detection, warning and effective environmental monitoring. Early warning means that potentially harmful organisms, such as alien species, parasites and disease organisms, are detected at such an early stage that it is possible to initiate measures to prevent or limit the most serious effects.

The main objective of the project is to develop tools for automatic monitoring in fresh water (rivers and lakes), so that the great potential that lies in environmental DNA (eDNA) can be utilized to the maximum. The unit we want to develop will be used under various conditions in fresh water for monitoring specific organisms relevant for management. We are especially in need of a tool to monitor the spreading of harmful alien species[1] and disease organisms such as *Gyrodactylus salaris*[2], *Batrachochytrium dendrobatidi*[3]*s* and Crayfish plague. In addition, we want a system that can be used to monitor endangered species and to classify ecological status according to the Water Framework Directive. In today's Norwegian classification system[4], about 250 species of invertebrates are used as indicator species for the determination of ecological status in fresh water. It is desirable that the solution we want developed, in the future can be modified to other applications and environments.

Development of a reference library for species identification is not part of this acquisition. Adaptation to the use of publicly available solutions for species identification, such as GenBank and the Barcode of life computer system (BOLD)[5], is required to ensure that data can be used in relevant monitoring programs. Standards are being developed under the DNAqua-net[6] in collaboration with the European Committee for Standardization (CEN)[7]. During the project phase, the tenderer must become acquainted with ongoing standardization and method development in the EU.

This document (Appendix B) includes a description of the customer's needs that are to be covered and that are related to the development of new technology for automatic environmental monitoring

[1] https://www.miljodirektoratet.no/globalassets/publikasjoner/m1373/m1373.pdf

[2] Handlingsplan mot *G. salaris*: http://tema.miljodirektoratet.no/Documents/Nyhetsdokumenter/M-2882014_rapport_nett.pdf

[3] *De sykdomsfremkallende soppene Batrachochytrium dendrobatidis og Batrachochytrium salamandrivorans og risiko for biologisk mangfold*, Vitenskapskomiteen for mat og miljø (VKM), 2019:04.

[4] Direktoratsgruppa vannforskriften: Klassifisering av miljøtilstand i vann, Veileder 02:2018

[5] http://boldsystems.org/

[6] https://dnaqua.net/

[7] https://www.cen.eu/Pages/default.aspx

using eDNA in freshwater. This document also describes our requirements for the design and content of the idea sketch.

More about the background, needs and potential uses can be found in Appendix E, and on this page: http://innovativeanskaffelser.no/automatisk-miljoovervaking/.

Customer needs

The Norwegian Environment Agency needs a system for automatic environmental monitoring adapted to the use of eDNA to identify individual species. Such a system will require various components to cover all the steps of automated environmental monitoring using DNA-based methodology.

It is desirable that each automated step / part (shown in Figure 1) can be used independently, whether or not the other steps are automated. However, there must be a plan on how all the steps can be used together in order to achieve a comprehensive system for monitoring using eDNA. In this way, each part that is automated will gradually contribute to improve and increase the efficiency of environmental monitoring. Increasing degrees (from steps A to C) of automation will be important in our overall assessment of the idea sketch. It is not possible to tender for only parts of the contract, cf. competition rules, section 2.7.

The main steps in an automatic system (illustrated in Figure 1):

A. Automatic collection of water samples, including sample preparation.
B. Automatic analysis of samples.
C. Automatic data processing and warnings.

Figure 1. Illustration of the various steps in automatic environmental monitoring. The first image shows a continuous collection of samples from water. Then the samples are processed, and DNA is extracted. Finally, the samples are analysed, and warnings are sent if anything undesirable is detected. Such a facility will allow early action to limit and prevent damage.

In Table 1, we have thematically listed and described our need for a comprehensive solution. We need a solution that is holistic and, as much as possible, automated and with a wide range of applications. However, we have set a priority from one to three in the table to illustrate that some needs are considered more essential than others. This is not an absolute priority list and should only be regarded as a guide, as we will carry out a comprehensive assessment of the idea sketch and the project plan.

Table 1. The table briefly describes our needs and overall requirements for function and priorities.

N0.	Pri.*	Topic	Description	Function
B01a	1	Automation step A (sample collection and processing)	The solution should, as far as possible, be comprehensive without need for manual handling. The steps must be compatible.	Comprehensive automation and compatibility
B01b	2	Automation step B (analysis)		
B01c	3	Automation step C (data processing, warning)		
B02a	1	Application – alien species, parasites and pathogens	The unit should be used to monitor alien species and pathogens in freshwater (rivers and lakes). Furthermore, it is desirable that the system can be used for monitoring endangered species and indicator species	Relevant applications for environmental management
B02b	2	Application – endangered species		
B02c	3	Application - indicator species (eg. water regulation)		
B03	2	Adaptation to new development and other applications	It should be possible to adjust the system to new methods and requirements for quality of sample analysis and data processing. The system should also be adaptable to new applications.	Options for adaption
B04	1	Mobility	It should be possible to easily assemble/ dismantle and move/transport the system according to the application	Mobility according to the application
B05	1	Freshwater functionality	The unit must function under the various conditions in freshwater that is required for different applications.	Level of functionality
B06	1	Frequency of sample collection	The collection frequency must be sufficient for early warning and measures to be taken for species relevant in management.	Frequency
B07	1	Sample preparation	The method for sample preparation (filtration etc.) and storing must ensure reproducibility and verifiability. The sample collection must be suitable for the analytical method and of a quality that ensures identification of species /species group.	Sample quality and precision of identification
B08	2	Contamination	The entire process from sample collection through to data analysis must give the lowest possible measurement errors / contamination.	Contamination rate / margin of error
B09	1	Quality of analysis	The sample analysis (for example, reading of DNA sequences) must be of such quality that it provides the fewest possible sources of error.	Estimation of uncertainty and precision of identification
B10	1	Data format	The data format for information and warning must be compatible with public systems available.	Compatibility with established systems
B11	3	Other measurement parameters	The device may also collect other relevant parameters (temperature, pH, salinity, mapping, etc).	Relevant parameters

B12	1	Maintenance	The need for maintenance and supervision should be as minor as possible.	Degree of maintenance
B13	2	Data security	Sufficient to fulfil current requirements for data security.	Degree of data security
B14	2	Protection towards theft and vandalism	The system must be designed so that it can be used without risk of theft and vandalism.	Degree of security
B15	3	Potential for scaling, capacity	The solution may have the potential of upscaling number of analyses	Upscaling capabilities and capacity
B16	1	Early warning	The system must provide warning sufficiently quickly to implement measures in time to limit / prevent damage to species / organisms being monitored.	Response Time
B17	1	Acquisition- and operating costs	The cost of procurement and operation should result in cost savings compared to existing methods.	Economy

* Priority indicates a scale of 1- 3, where 1 is most needed and 3 is least needed. In our assessment, this priority will not be linked to a specific score but will be of help for the comprehensive assessment.

Requirements for the idea sketch

Tenderer must respond according to the following requirements for the design and content of the idea sketch and specification;

- The tenderer must, as a minimum, present one idea of solution, describe the best available technology and present what it takes to technically and financially develop a comprehensive system during the project period. The tenderer may describe several possible solutions for each step. It is important that the offer includes an estimate of the cost of acquiring and operating the automatic monitoring system. If the units that are part of the comprehensive system can be used separately, the acquisition and operating costs for each part must be estimated. The estimates must be justified.

- The idea sketch should include all the steps. Tenderer can provide specific description / idea for only one of the steps but must then be able to put it in the context of existing solutions that include all the steps and include a plan for integration.

- The technical solutions proposed should be described in detail and the choice of methodology should be justified. Potential challenges / risks in development and operation shall be discussed including proposals for measures to limit the risk. The numbers in Table 1 should be referred to in the idea sketch.

The various ideas proposed will vary in character. If one of the points in the Table 1 is considered less relevant to the proposed idea, this must be elaborated and justified. The response and proposal for an idea should be attached as annex 5.