



PROJECT NAME:

Improvement of health status of population of the Slovak Republic through drinking water re-carbonization (LIFE 17 ENV/SK/000036)

Acronym **LIFE – WATER and HEALTH**

Coordinating Beneficiary: *Comenius University in Bratislava, Faculty of Natural Sciences*

Replicability and Transferability Plan

Replicability and transferability plan is based on the following three basic assumptions:

1. Full and detailed publication of all results achieved on the project website,
2. The high importance of the achieved results for people's health,
3. Wide dissemination of the achieved results after the end of the project.

In terms of the project, it lists the main results and outputs achieved within the project in the form "friendly" to wide public and scientific audience to ensure their replicability and transferability:

- a) Methodology for health risk assessment from the deficiency of biogenic elements,
- b) Characteristics of the rock material for the recarbonization process,
- c) Measurement of vascular elasticity,
- d) Detailed technical characteristics of the manufactured prototypes of recarbonization reactors,
- e) Monitoring the content of Ca and Mg in recarbonized water,
- f) Summarizing the experience in the installation and operation of recarbonization reactors.

a) Methodology for health risk assessment from the deficiency of biogenic elements

A new methodology for calculating the health risk for the deficient content of biogenic elements was developed as part of the project. This is a supplement to the US EPA methodology with a deficit content of biogenic elements. This methodology is also suitable for calculating the health risk for other components of the environment – soil, air, sediments, food and for other biogenic elements. The advantage of this methodology is that it uses the same exposure scenarios and the same rating scale as the US EPA defined health risk calculation methodology.

The methodology was published in the world literature and is therefore available to a wide professional public.

b) Characteristics of the rock material for the recarbonization process

Based on laboratory testing of various rock materials, we recommend half-burnt dolomite (HBD) for the recarbonation process. The main reason is the fact that it is the most suitable of the carbonate rocks, and when it dissolves, Ca and Mg are released into the liquid phase in the form of bicarbonates, that is, in the form as it is in natural waters, and these biogenic elements are thus fully bio-accessible for the human body. Another reason is the fact that Mg, which is more important for human health than Ca, is preferentially released from HBD into liquid form. Rocks based on chlorides, sulphates, or nitrates are not suitable, because when they dissolve, a high content of chlorides, sulphates, and nitrates is released. For human health, it is best when the Ca and Mg content is in the form of bicarbonates. In this case, the pH of enriched water is also in the slightly alkaline range, and the health risk of acidification of the organism is reduced.

c) Measurement of vascular elasticity

The elasticity of blood vessels (so-called arterial stiffness) is an important risk factor for developing cardiovascular diseases (CVD). By measuring the elasticity of blood vessels, it is possible to identify the probability of developing CVD even before clinical symptoms. Through our research, we have proven and introduced into the world literature the knowledge that the low content of Ca and Mg in drinking water causes increased stiffness of blood vessels and increases the risk of developing CVD. We have clearly confirmed that the content of Ca and Mg in drinking water affects the elasticity of the blood vessels of the inhabitants, and therefore the deficient content of Ca and Mg is a very important factor in the risk of developing CVD. The results of measuring the elasticity of blood vessels are expressed as the arterial age of people (or the difference between the actual age and the arterial age) and the pulse wave velocity. The lower the arterial age and pulse wave velocity, the better the cardiovascular system of people. The most important result of measuring the elasticity of blood vessels was obtained by measuring respondents who initially consumed drinking water with a low content of Ca and Mg after the drinking water enriched with Ca and Mg. We have confirmed that the arterial age and pulse wave velocity of the respondents in two municipalities (Devičie, Kokava nad Rimavicou) in the Slovak Republic are significantly improving. The arterial age of the respondents decreased by almost 10 years on average after 18 months of drinking water enriched with Ca and Mg. This fact clearly indicates the beneficial effect of increased Ca and Mg content in drinking water on human health.

d) Detailed technical characteristics of the manufactured prototypes of recarbonization reactors

The detailed characteristics of both manufactured prototypes of recarbonization reactors (RR) are completely available on the project's website. It is also published in international high-impact magazines. One RR (Devičie) is designed for an annual water consumption of approximately 10,000 m³ per year and the other RR (Kokava nad Rimavicou) is designed for an annual consumption of approximately 110,000 m³ per year. Based on our results,

potential applicants can construct a RR according to their own needs, according to specific annual water consumption.

e) Monitoring the content of Ca and Mg in recarbonized water,

Based on the results of the 18-month monitoring of drinking water enriched with Ca and Mg in the Devičie and Kokava nad Rimavicou water sources, it was clearly confirmed that both RRs work reliably and the necessary long-term increase in the content of Ca and Mg in drinking water is a realistic assumption.

f) Summarizing the experience in the installation and operation of recarbonization reactors.

The recarbonization reactor must be adjusted after commissioning. It is necessary to change the performance of the circulation pumps, the amount of HBD and CO₂ added. It is necessary to find out under which conditions it is most effective. Under what conditions can it produce the highest possible content of Ca and Mg in the aqueous solution. Our experience shows that the efficiency of RR is most influenced by the performance of the circulation pump, less by the amount of added HBD and least dependent on the amount of CO₂ added. When we add a large amount of HBD, the effect of fluidization is reduced and the production of Ca and Mg ions is reduced. When monitoring the content of Ca and Mg in enriched water, it is enough to monitor the value of conductivity. The conductivity value can be used to determine the content of Ca and Mg in the drinking water after long-term operation of the RR. We recommend monitoring the free CO₂ content in the produced concentrate water. The free CO₂ content should not exceed 100 mg.l⁻¹. Such a value of free CO₂ is fully used to dissolve the microparticles of carbonate rock created during the fluidization process and guarantees the pH of the resulting drinking water in the neutral to slightly alkaline range.