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Importance of Heat Insulation for Creating Energy Efficiency in Current Buildings: Bursa, Nilüfer/Turkey Example

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Abstract
The majority of the current building stock in Turkey is composed of buildings that are not insulated. One of the most important items of the agenda is insulating these buildings in time to use energy efficiently (to create energy efficiency). Due to the increase of residential energy consumption related to heating and cooling, suggestions to speed up the transformation of uninsulated buildings to insulating buildings are needed. Similar to the rest of the world "Measures to Increase Energy Efficiency of Buildings" are among the future goals of administrational policies. Taking into consideration all the research in this area the residential Ataevler Quarter in the Nilufer district of the city of Bursa - the 4th largest city in Turkey - was selected for the analysis in the scope of this paper. There are a total of 2891 apartments in the research area, which is composed of 16 building complexes and 254 building blocks. The research will first analyze the current situation of the residential area. After the initial analyses CO_2 emissions (tons), heating energy need (kWh/m^2) and heat loss amount (kWh) that will have acquired after insulating uninsulated buildings will be presented. The analyses have shown that insulating walls and roofs of the current buildings will reduce CO_2 emissions and fuel consumption almost by 30%. The contribution of this savings to the national economy, budget of the users, and protection of the buildings and the environment is significant. It is believed that the data should be presented to and evaluated by relevant parties in order to contribute to the development of future strategies that aim to reduce energy consumption of current buildings to the minimum.

Keywords: Energy efficiency, heat insulation, insulation of buildings

1. Introduction

Because residential buildings are responsible for 30% of the energy consumption throughout world efficient usage of energy becomes important at every step starting from the design of buildings. The necessity to "…meet the needs and aspirations of the present without compromising the ability of future generations to meet their own needs" (Report of the World Commission on Environment and Development, 1987) also refers to the need to aim for efficient energy usage also in the construction sector and architectural design / implementation approaches. One of the design principles for humans is to create the comfort conditions that have a positive impact on psychological and physical health. The criteria that are necessary to fulfil the principles of "design for

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people" and "transferring a liveable world to future generations" should be: minimum costs, minimum energy consumption and minimum environmental pollution.

Energy efficiency is defined as: Using the minimum amount of energy without preventing economic development and social welfare." Standards have been developed by various civil society organizations, private and public institutions throughout the world to create sustainable buildings and construction products. Scoring systems have been developed to indicate the level of achievement of buildings in relations to such standards. An "Energy" criterion is one of the important aspects of the evaluation in such systems.

The majority of the current building stock in Turkey is composed of buildings that are not insulated. One of the most important items of the agenda is insulating these buildings in time to use energy efficiently (to create energy efficiency). And these buildings make up the larger portion of the building stock in cities. Residences are where people spend a large portion of their lives. Besides their economic value residences mean many things for people. Also the usage costs of residences have a large share in the ecologic and economic cycle of the cities that they are located. A starting point to create awareness on sustainability for the urban dwellers could be directing them to work on their own residences, which could provide short term solutions. The goal and purpose of this study is explained in Figure 1.

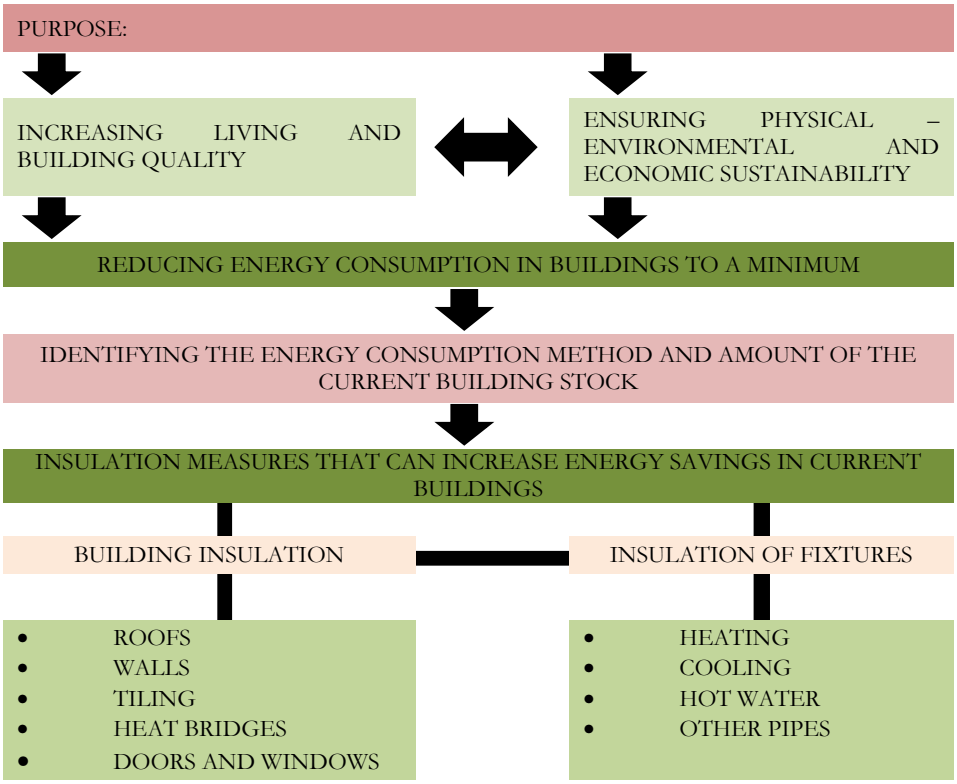

Figure 1. Goal and purpose of this study: Reducing energy consumption of buildings to a minimum

Due to the increase of residential energy consumption related to heating and cooling, suggestions to speed up the transformation of uninsulated buildings to insulating buildings are needed. Similar to the rest of the world "Measures to Increase Energy Efficiency of Buildings" are among the future goals of administrational policies. It is believed that the data should be presented to and evaluated by relevant parties in order to contribute to the development of future strategies that aim to reduce energy consumption of current buildings to the minimum.

2. Energy Efficiency Activities and Measures in Turkey

When regulations related to insulation applications in Turkey is examined it can be seen that the first one was prepared by the Turkish Standards Institution in 1970 entitled "TS 825 Heat Insulation Rules for Buildings". But during that period no obligations were set to implement this regulation. The regulation introduced in 1977 by the Ministry of Energy and Natural Resources entitled "Regulation to Economize Fuel Consumption in Heating and Steam Facilities and to Reduce Air Pollution" was an important step in this regard. The "Heat Insulation Regulation" was put into force on 30.10.1981 and on 16.01.1985 some amendments were made. IN 1995 Ministry of Energy and Natural Resources started revising the Regulations on "TS 825 Heat Insulation of Buildings" and completed the revised regulation on 19 April 1998, which entered into force after it has been approved by the TS Technical Board. The TS 825 standard was published in the official gazette's issue 23725 dated 14.06.1999 and from 14.06.2000 started to be used in new buildings as the mandatory standard. From this date on current buildings were required to act on the legal framework but all new buildings were obliged to meet heat insulation criteria in this standard. With a revision made in 2008 buildings were allowed less heat dissipation and therefore their energy needs were decreased.

Energy Efficiency Law No 5627, which defines the principles related to efficiently and effectively using energy and energy sources in Turkey, preventing energy waste and preserving the environment entered into force in 2007. An important step for energy efficiency was taken with the Energy Performance Regulation in Buildings, which came into the agenda in 2008 and accepted on 05.12.2009. In parallel to these developments the Kyoto Protocol was signed on August 26, 2009.

As of January 1, 2011 the Energy Identity Document (EKB) certification started. Energy Identity Documents became obligatory for new buildings and current buildings that are larger than 1000 square meters (to be obtained before 02.05.2017). For a building to be issued an energy identity document the building energy performance needs to be calculated. The online software specifies the energy performance of the building and creates an energy identity document. Energy Identity Document expertise trainings are provided by universities, professional chambers and relevant institutions and organizations that are authorized by the Ministry and the General Directorate of Renewable Energy based on mutual protocols. Energy Identity Document holds information related to the building itself, energy consumption class, CO2 emission class, minimum energy requirement, and renewable energy rate of the building, and also energy consumption class (Classes A, B, C, D, E, F, G) related to heating, hot water, cooling,

ventilation, lighting, and insulation status (Figure 2). After being issued it is valid for 10 years. At the end of this period the Energy Identity Document is reissued based on a report. Buildings that are classified as D for their energy consumption need to be improved with measures that increase energy efficiency.

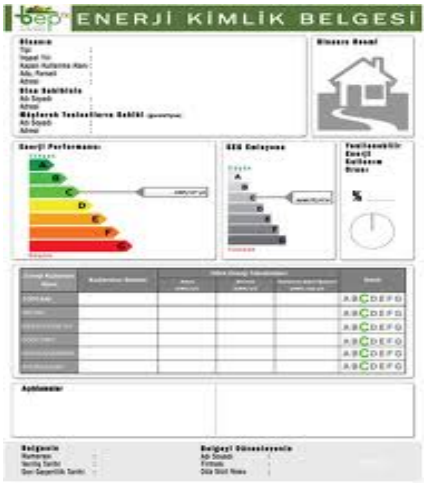

Figure 2. Energy Identity Document

It is foreseen that by 2020 the energy consumption in Turkey will reach 47.5 million TOE whereas only 22% of the total energy demand will be met with domestic production (TEVEM, 2012). It is targeted to decrease energy consumption by 10% until 2015 and by 20% until 2023. "Measures to Increase Energy Efficiency in Buildings" is among the 2012 goals of the Ministry of Public Works and Settlement.

According to the data of Ministry of Energy and Natural Resources it is foreseen that the CO2 emissions will reach from 53,4 million tons in 2009 to more than 100 million tons in 2020 (Ministry of Energy and natural Resources, 2010). Ministry of Energy and Natural Resources has accepted the "Energy Efficiency Strategy Document 2012-2013" based on the provision in the official gazette dated 20/02/2012. Insulating current building stock was indicated as a goal to reduce energy usage for heating and cooling purposes.

The latest activities related to taking building inventory were made in 2000. According to the 2000 data of the State Statistics Institute there are a total of 7 million 838 thousand buildings and a total of 16.2 million dwellings. It is estimated that the building stock is 20 million as of the year 2012 (Turkish Energy Institution, 2012). It is argued that 5% of the current building stock has heat insulation and that even after TS 825 heat insulation have been properly implemented only in 20% of the buildings (TEVEM, 2012). According to these data it is important to take initiatives to increase energy performance of current buildings and especially in residential buildings.

Due to the increase of residential energy consumption related to heating and cooling, suggestions to speed up the transformation of uninsulated buildings to insulating buildings are needed. It is foreseen that with heat insulation in 10 million

dwellings until 2023 will create cooling savings with an amount of 2400 GWh and 2,3 million TEO fuel savings (Ministry of Energy and Natural Resources General Directorate of Renewable Energy, 2012). At this point the inventory of the current building stock related to energy efficiency and minimum resource utilization needs to be taken.

Since 2011, it has been obligatory to have a C class energy performance certificate for all of the new buildings before their occupancy permits. Another obligation is the necessity of having an energy performance certificate for all the buildings in stocks disregarding their classes, till 2017. The aim of these precautions is to improve the physical conditions of the ¼ of the existing buildings in order to make them appropriate for sustainability criteria till 2023. They have to have C Class energy performance certificate in order to be appropriate for sustainability criteria. Validity period of these regulations will begin in 2017. However, this dateline causes the residents to ignore the requirements about their residential buildings. Another factor affecting this negligence is the economic cost of getting these certificates. The number of residential units built since 2011 in Bursa and the number of energy performance certificates they have got can be seen in Table 1. The numbers are according to 2014 data of Ministry of Environment and Urban Planning.

Table 1. Data of built residential units and their certificates in (Ministry of Environment and Urban Planning, 2014)

Type	Number of Buildings	Number of Certificates
Detached House	660	599
Flat in Apartment Block	7096	6867
Flat in Residences	26	25

3. Case Study

Residential buildings make up the larger portion of the building stock in cities. Residences are where people spend a large portion of their lives. Besides their economic value residences mean many things for people. The usage costs of residences have a large share in the ecologic and economic cycle of the cities that they are located. A starting point to create awareness on sustainability for the urban dwellers could be directing them to work on their own residences, which could provide short term solutions.

Taking into consideration all of these the residential Ataevler Quarter in the Nilufer district of the city of Bursa - the 4th largest city in Turkey - was selected for the analysis (Figure 3).

Figure 3. The region selected for the analyses: Ataevler / Nilufer / Bursa

The region selected for the analyses is composed of building blocks constructed between 1989 and 1999. The Nilufer district at the western part of the city is developing faster than the eastern region of the city. This is a region where the current building stock could be improved in terms of energy efficiency. There are 16 building complexes, 254 blocks and 2891 dwelling covered by the field study (Table 2 – Table 3).

When the ownership status of the users is evaluated it is seen that 63% are owners, 36% are renters and 1% is living at a family member's or a relative's house without paying rent. It is believed that the data to be collected and the results of evaluations will light the way for the development of future strategies related to reducing energy consumption to a minimum in current buildings.

In the scope of the analysis 3 (19%) of the buildings were constructed in 1988-1990; 1 (6%) was constructed in 1991-1993; 8 (50%) were constructed between 1994-1996; and 4 (25%) were constructed between 1997-1999. 2 (12%) of the building complexes are composed of a ground floor+3 stories; 11 (69%) are composed of a ground floor+4 stories, 2 (13%) are composed of a ground floor+5 stories, and 1 (6%) of them are composed of a ground floor+7 stories. Apartments in 2 of the building complexes (12%) are 75-84 sqm; 8 (50%) are 85-94 sqm, 2 (13%) are 95-104 sqm, 3 (19%) are 105-114 sqm and only 1 (6%) is 115-124 sqm. All the buildings have plastic joineries. Original woodwork that was installed during the construction has been changed to double glazed windows and plastic joineries.

Table 2. Analyses of the buildings – 1

ANALYSES		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Building name		Site A	Site B	Site C	Site D	Site E	Site F	Site G	Site H
Year of construction		1988	1989	1989	1992	1995	1995	1995	1995
The number of blocks		14	14	7	5	37	8	10	5
The number of apartments		144	140	105	80	444	80	80	108
Construction systems		Reinforced concrete	Reinforced concrete	Reinforced concrete	Tunnel formwork system	Reinforced concrete	Reinforced concrete	Reinforced concrete	Reinforced concrete
Total floor		Ground floor + 4	Ground floor + 5	Ground floor + 4	Ground floor +7	Ground floor + 4	Ground floor + 4	Ground floor + 3	Ground floor + 3
Squaremeters		89	90	75	124	90	85	100	80
The wall material		Brick wall	Brick wall	Brick wall	Brick wall	Brick wall	Brick wall	Brick wall	Brick wall
Insulation status	wall	Uninsulated	Uninsulated	Uninsulated	Uninsulated	Uninsulated	Uninsulated	2 cm strophor	Uninsulated
	roof	Uninsulated	Uninsulated	Uninsulated	2 cm strophor	Uninsulated	Uninsulated	Uninsulated	Uninsulated
Joinery material		Plastic	Plastic	Plastic	Plastic	Plastic	Plastic	Plastic	Plastic
Heating type		Natural gas	Natural gas	Natural gas	Natural gas	Natural gas	Natural gas	Natural gas	Natural gas
Heating system		Combi	Central system	Combi	Combi	Combi	Combi	Combi	Central system
Heating		Radiator	Radiator	Radiator	Radiator	Radiator	Radiator	Radiator	Radiator

Table 3. Analyses of the buildings – 2

ANALYSES		**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
Building name		Site I	Site J	Site K	Site L	M	Site N	Site O	Site P
Year of construction		1995	1996	1996	1996	1997	1997	1998	1999
The number of blocks		16	35	16	20	11	15	28	13
The number of apartments		192	420	176	216	88	150	338	130
Construction systems		Reinforced concrete	Reinforced concrete	Reinforced concrete	Reinforced concrete	Reinforced concrete	Reinforced concrete	Reinforced concrete	Reinforced concrete
Total floor		Ground floor + 4	Ground floor + 4	Ground floor + 4	Ground floor + 4	Ground floor + 4	Ground floor + 5	Ground floor + 4	Ground floor + 4
Squaremeters		85	85	114	85	110	90	111	100
The wall material		Brick wall	Brick wall	Brick wall	Brick wall	Brick wall	Brick wall	Brick wall	Brick wall
Insulation status	wall	Uninsulated	Uninsulated	3.5 cm EPS (2009)	Uninsulated	Uninsulated	Uninsulated	Uninsulated	Uninsulated
	roof	Uninsulated	Uninsulated	8 cm glasswool (2009)	Uninsulated	5 cm glasswool (2007)	8 cm glasswool (2011)	Uninsulated	Uninsulated
Joinery material		Plastic	Plastic	Plastic	Plastic	Plastic	Plastic	Plastic	Plastic
Heating type		Natural gas	Natural gas	Natural gas	Natural gas	Natural gas	Natural gas	Natural gas	Natural gas
Heating system		Central system	Combi	Combi	Combi	Central system	Combi	Combi	Combi
Heating		Floor heating	Radiator	Radiator	Radiator	Radiator	Radiator	Radiator	Radiator

75% of the buildings are heated with combi boilers, whereas 25% are heated with central heating systems. When the fuel costs for heating are calculated it is seen that 69% spend 350 – 550 Euros, and 31% of the buildings spend 250 – 350 Euros. The calculations are done between 2015 October and 2016 March.

Of the 256 building blocks, 197 have uninsulated roofs and uninsulated walls; 31 have insulated roofs and uninsulated walls; 16 have insulated walls and insulated roofs; 10 have uninsulated roofs and insulated walls. When the current insulation of the apartments is examined it is seen that 78% are uninsulated, 12% only have insulated roofs; 6% have both insulated walls and roofs; and 4% have only insulated walls.

Bep_TR program was used to measure the current CO_2 emissions and yearly heating energy needs of buildings and the values that will be achieved after these buildings are insulated (Figure 4).

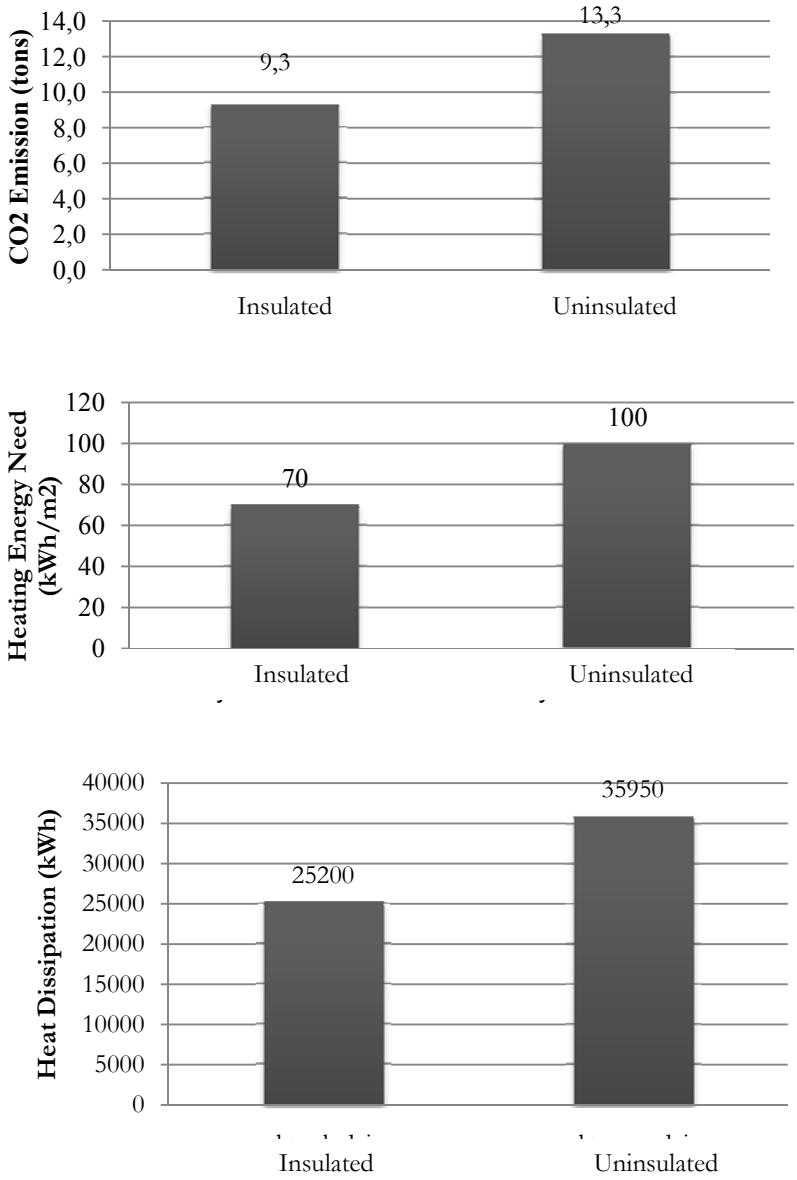

Figure 4. Insulated and uninsulated condition of buildings

It is calculated that insulating walls and roofs of the current buildings will reduce the CO_2 emissions and fuel consumption almost by 30%. This gain will contribute significantly to the national economy, budget of users, preservation of buildings and the environment. In line with this, it has been calculated in a building complex, which had its walls and roofs insulated in 2009, that the complex had 25-30% reduction in their yearly heating costs (Table 4).

Table 4. Gains after insulating buildings

	Uninsulated	Insulated	GAINS
CO_2 emissions (ton)	13,3	9,3	4
Heating energy need (kWh/m^2)	100	70	30
Heat loss amount (kWh)	35950	25200	10750

Average Yearly Heating Energy Gain: > 80.000 kWh/m^2
Average Yearly CO_2 Emission Gain: > 3000 tons
Average 1 Year Savings: > Euro 300 000

This gain will contribute significantly to the national economy, budget of users, preservation of buildings and the environment. It seems that necessary activities to encourage insulation and issuing Energy Identity Documents would be possible by integrating local governments to the process in this region, where more than half of the dwellers are owners of their dwellings.

4. Discussions and Suggestions

In a country that has large building stock suggestions for solutions that can provide maximum energy performance in current buildings is needed. Therefore, private and public bodies need to come together to prepare necessary regulations, laws and bylaws. Issuing Energy Identity Documents for buildings in the scope of the Energy Performance Regulation in Turkey is narrow scoped when compared to systems used in the world. A certification system based on different types of buildings is needed because of the conditions in Turkey. Making regulations compulsory for only new buildings is not enough. It will be hard to reduce the environmental impact if high consumption is not reduced. Awareness of the whole public needs to be increased to be successful in saving energy. The future studies will focus on the consumption of natural resources and will be shared with the public in order to increase awareness.

With inclusion of local government, it is possible to prepare Energy Performance Certificates for buildings and initiate the required studies about promoting insulation. However, at this point the parameters affecting the efficiency of the insulation must be kept in mind to get the expected output of insulation applications.

It is estimated that the number of housing units in Turkey will be 25.56 million in 2023. It is supposed that approximately 7.56 million new built housing units will have C class certificate. Another presumption is that, with the help of the refurbishment studies 12.06 million housing units will be energy efficient (Association of Real Estate Investment Companies, GYODER, 2014). Having been conscious about the validity of the situation, the authors put stress on the necessity of stimulating measures for this regulation about the energy efficiency certificate systems in Turkey, where there is a high demand of low and middle income housing units.

Under the Energy Performance in Buildings Regulation, the preparation of energy identity documents of buildings is a narrower-scoped study according to the accepted systems all over the world. It is necessary to be edited a certification system

required for various building types. That the regulation is only mandatory for new buildings is not enough. As long as excessive consumption is not reduced, reduction of environmental impacts will be difficult. To be successful in energy saving will be possible with the acceptance of consciousness by the society as a whole. In the next studies, it is aimed to increase of studies including users' consumption of natural sources and share the conclusions with the public to contribute to improving public awareness. We can indicate the priority works to be done with collaboration of the related actors with a participative approach as follows;

- Design of different certification systems for different regions of Turkey with different types of climates as well as for different types of buildings,
- Development of the related laws and legislations in order to make them be able to describe the things to do not only for the new buildings, but also the existing ones,
- Development and implementation of educational programs for raising the level of awareness about the importance of energy efficiency for a sustainable world,
- Development of collaborative projects in order to raise the public consciousness about minimum natural resource use and minimum energy use

The priority task of the authors is to undertake various case studies and share the outcomes of these case studies with public and local authorities in order to support the studies about raising public awareness. Being conscious about the importance of collaboration, the authors share their knowledge and experiences with people and local authorities within the context of their research projects.

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