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Sustainable water management and local communities: strategies and case studies to achieve SDG 6 in Hungary

Climate change affects all areas of our lives, especially the quality and quantity of water. The 6th goal of the Sustainable Development Goals deals with problems affecting water, and among its goals, local communities are also given a significant role, just like in the European planning documents. These documents promote sustainable water management solutions that enable integrated and cost-effective interventions. In this paper, I am looking for the answer to how sustainable water management solutions can contribute to the fulfilment of SDG 6 and what effects they have on local communities. In addition to the relevant literature and document review, I conducted expert interviews with specialists who were already involved in such projects and I analyse three case studies with sustainable water management solutions. Results show that these solutions have a significant impact not only on the physical natural environment, but also on residents' habits and they have a strong identity-forming role, so they are suitable to contribute to the fulfilment of SDG 6.

Keywords: Sustainable Development Goals, water affairs, sustainable water management, local community, local development

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Introduction

Based on data from the United Nations, over the past 300 years, over 85% of the planet's wetlands have been lost and more than 700 million people were living in countries with high and critical levels of water stress in 2019 (UNESCO, 2019). According to a global assessment of the impact of climate change on water scarcity (Gosling and Arnell, 2016), it is possible that 53% of the global population will suffer from water scarcity. Since the launching of the Sustainable Development Goals (SDGs) in 2015, governments, local authorities, NGOs and businesses are making serious efforts to meet them. SDG 6 (clean water and sanitation) addresses targets directly related to water issues. Although Hungary is called the "country of waters", water scarcity problems in the country are set to increase in the coming years, making it crucial to address SDG 6; for example, flood protection problems, summer droughts and municipal water problems requiring immediate action by the authorities. In this paper, I am looking for the answer to how sustainable water management solutions can contribute to the fulfilment of SDG 6 and what impacts they have on local communities in Hungary.

My paper is based on qualitative methodology, starting with a comprehensive analysis of relevant literature and an assessment of existing policies. I conducted two semi-structured interviews with experts on the field. These experts work for the Association of Climate-Friendly Municipalities and have been involved in several sustainability-related projects, in particular projects promoting sustainable water management solutions in Hungary. Finally, I also analyse three case studies that are truly forward-looking and contribute to the SDGs as small-scaled developments, and I show the benefits of these solutions for local communities in the light of the interviews.

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Sustainable urban water management in the light of international agreements

Introduction of SDG 6

In the 20th century, the phenomenon of sustainability became extremely important (Popescu et al., 2017). Sustainability has many interpretations, and a comparison of these would be worthy of a separate study; e.g., there are strong and weak views of sustainability (Kerekes, 2008). One definition is that sustainability is economic growth that provides opportunities for all the inhabitants of the Earth without exploiting the Earth's resources (Pronk and Haq 1992). This definition introduces the principle of intragenerational solidarity into territorial development, which adapts the definition of the 1987 Brundtland report (WCED, 1987) to include the requirement of solidarity between all those living at the same time: “Sustainable development is development that meets the needs of those living here without compromising the ability of those living elsewhere to meet their needs” (Fleischer 2014, 16). Sustainability has three main pillars (the triple bottom line): society, economy and environment; they cannot be interpreted without each other (Gyulai, 2000), and they are embedded and closely interacting with each other (Fleischer 2014, Tóth and Kozma, 2016).

Over time, the issue of sustainability has also been included in international agreements. The Millennium Development Goals (MDGs) were adopted in autumn 2000 (UN, 2000), but they focused on poverty reduction rather than sustainability (Waas et al., 2011; Jancsovszka, 2016). The development of the Sustainable Development Goals (SDGs) was led by the UN mid-term review conference on the MDGs and the Rio 2012 Earth Summit. The SDGs consist of 17 general goals, which can be further broken down into sub-goals, all focusing on different aspects of sustainability. The goals cover both the social and environmental dimensions of sustainability, but there are also economic objectives (e. g. Goal 8). The SDGs can be understood as networks, linked by their sub-goals and targets (Le Blanc, 2015). A general problem with the SDGs is the lack of sufficient policy integration to address sustainability issues effectively (Jancsovszka, 2016). Many of the current debates on the SDGs are about the measurability of the goals and the production of data, as continuous monitoring would be needed with systematic and consistent data production (Benedek, 2021).

Water is an essential, vital resource for humanity and the last century has caused serious damage to the state of our waters, including in Europe (Reich, 2019). SDG 6 addresses water-related targets and indicators and it has eight specified targets (UN). Although the targets are indeed focused on important areas of water consumption and are comprehensive, it is notable that some raise serious questions about feasibility and measurability. However, addressing SDG 6 is crucial because without taking water issues into account, other goals will remain unachievable (e.g., SDG 15 – Life on Land) (Dombrowsky et al., 2016).

In this paper, I focus on the national-level feasibility of the following objectives:

- Target 6.5: By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate;
- Target 6.6: By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes;
- Target 6.a: By 2030, expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies;
- Target 6.b: Support and strengthen the participation of local communities in improving water and sanitation management.

As we can see, these targets can be addressed on local (urban) levels very well, whether with small or large-scale investments. The place-based narrative for development was given a prominent role in the EU's 2014–2020 programming cycle, as they realised the importance of the potentials of local communities (Pfeil, 2020). The EU Water Framework Directive and the rules on circular

economy highlight the need for integrated management of water issues, and hydrological problems linked to climate change (e. g. flash floods) are having a disproportionate impact on local communities. For these reasons, an integrated approach to water by municipalities is an essential part of climate change adaptation and mitigation (Szöllősi-Nagy, 2018, Balatonyi et al., 2021). For these reasons, the focus in this paper is on local strategies and local solutions.

The introduction of water affairs in further strategies

2015 was a particularly remarkable year for sustainability (Karajz and Kis-Orloczki, 2019). In December 2015, the Paris climate agreement was signed after issuing the Agenda 2030 in September 2015 (Dombrowsky et al., 2016). The agreement clearly shows that climate change will have a significant impact on water resources and it gives climate change adaptation the same priority as mitigation. However, water-related issues are not highlighted enough, even though climate change shows its most direct impact through water. In line with the Paris agreement, the European Union committed to becoming climate neutral by 2050 (EC, 2022).

The United Nation's Climate Action Pathway – Water (2021) sets out more specific visions for water-related issues. This highlights the necessity of sustainable water management in agriculture, industry and settlements. There is an emerging need to conserve water ecosystems and to enhance biodiversity; "Half of all freshwater ecosystems and inland waters, particularly those that have the greatest potential to sequester carbon, such as wetlands, peatlands and mangroves, are protected and restored" (UNFCCC 2021). The document also states that climate change is primarily manifested through water and establishes milestones until 2040 which have economic, social and environmental implications; special attention is given to cooperation with civil society organisations and communities through pilot programmes.

The European Water Framework Directive was adapted in 2000, and since then this has been the primary law for water protection in the European Union. The Directive emphasises that increasing population, urbanisation and economic activities are putting significant pressure on freshwaters in Europe. The Directive highlights the need for cooperation between neighbouring countries to manage together their shared waters (e.g., rivers), because pollution spreads across borders. The review of the Directive in 2019 (Fitness Check) shows that the Directive had an exceptionally good impact on water protection and flood risk management, but further development is needed. Monitoring is also limited because municipalities do not have enough resources (financial and technical) for this purpose (Rivas et al., 2022). The Water Framework Directive is supported by many more specific directives.

Water affairs in Hungarian regulation

The protection of water appears in the Fundamental Law of Hungary as a common heritage to be preserved. The Kvassay Jenő Plan (the national water strategy), adopted in 2017, integrates the Sustainable Development Goals (Reich, 2019). The main objectives pursued by the plan are improving water quality, increasing water efficiency, implementation of integrated water management on all levels, protecting aquatic ecosystems, international cooperation and supporting the participation of local communities. The plan is also in line with EU water policy, in particular the Water Framework Directive and the Floods Risk Management Directive. The Plan states that local municipalities and water-utility companies have the most significant role in municipal water management. The vision for 2030 includes having enough water available for users, focusing on prevention of damage caused by water than protection against it and upgrading the quantity and quality of exploitable water resources to a good status. The long-term goals already include soft targets such as improving the relationship between water and society, which could include local communities, but they are not given a prominent role in the rest of the plan. However, the Plan emphasises that the partnership of local communities can help to coordinate the use of VP, KEHOP and TOP funds.

Since 2019, municipal water management has been a priority in the activities of the General Directorate of Water Management (Balatonyi et al., 2021). Local authorities should rely on their Integrated Urban Water Management Plans, which are the basic documents for local urban water management (Reich, 2019). The purpose of this document is to integrate economic and environmentally supportive, sustainable water management tasks and their foundations into a coherent, operational system.

Sustainable water management solutions in the service of communities

Understanding sustainable and integrated water management solutions

As we have seen in the previous section, sustainable, integrated water management solutions are desirable to achieve international and national water goals, involving local communities and society. We must realise that it is getting more and more difficult to meet the growing water demand of the population with conventional water management solutions (Bahri, 2012), so it is necessary to examine and address local needs and problems related to water. In urban planning, professionals are increasingly confronted with the problem that water as an environmental element is not available in a sufficient quantity or quality (Gayer and Ligetvári 2007). Integrated urban water management is about how settlements can manage water and water-related infrastructure and services in a sustainable way. The principles of integrated urban water management are recognising the importance of alternative solutions, understanding storage, distribution and treatment as a cycle, and addressing economic efficiency, social equity and environmental sustainability at the same time.

Sustainable water management solutions (SWMSs) provide a tool to balance water demand and availability (Ding and Ghosh, 2017). According to Darvay et al. (2021), sustainable water management systems are those that function in accordance with society's needs for now and in the future, while they preserve the ecological, environmental and hydrological integrity. The Water Foundation's definition says that "Sustainable water management means using water in a way that meets current, ecological, social, and economic needs without compromising the ability to meet those needs in the future" (Myatt et al., 2019, p. 3). In the past years, governance and cultural adaptation is a crucial concern (Pahl-Wostl, 2008). Catley-Carlson (2012) highlights that water management starts on a local level, as the local water management reflects the country's, region's or village's characteristics like culture, religion and geography. It is also essential that water solutions must be adapted locally to be successful, and sharing data, information and best practices is crucial. The methods and technologies can be designed locally, but they are more valuable if they are built on the experience of others, underlining the need to share good practices. These solutions require a decentralised approach, which has many positive effects on the infrastructure, environment and local communities; they are able to promote innovation, support a more efficient use of resources and have a good impact on the local community's well-being (Marlow et al., 2013). According to Cosgrove and Loucks (2015), the question of centralisation is almost irrelevant, because it is particularly desired that local systems be part of larger physical and institutional contexts and the choice must be based on economic analysis.

Positive impacts of SWMSs on local communities

Bottom-up approaches are particularly important in the pursuit of the SDGs (Szép et al., 2019). However, results of Karajz and Kis-Orloczki (2019) shows that during social innovation, natural elements are marginalised. At the same time, the reviewed documents and literature also suggests that local communities and NGOs should be involved in sustainability efforts in both mitigation and adaptation, but this social aspect of SWMSs is not properly represented in the academic literature. Research from Mali shows that institutions must be flexible to adapt the needs of local communities in water management and it is necessary to ensure interactive communication between socially diversified stakeholders (Gleitsmann et al., 2007). Stakeholder engagement is a key factor for the success of SWMSs because it provides methods and solutions to a variety of

challenges in order to achieve the desired goal (Megdal et al., 2017). In addition to communication, ongoing education is equally important (Ostrom, 1990; Uphoff, 1992; Gleitsmann et al., 2007; Fernald et al., 2012; Spence et al., 2018); knowledge is passed down from generation to generation in local communities, so training local farmers is fundamental for climate adaptation (Fernald et al., 2021). These learning processes can shape the identity of local communities (Pahl-Wostl et al. 2008). Another study from the UK shows that projects with high degrees of social capital are more likely to have an impact on the social and environmental objectives of the public sector (Berka and Creamer, 2018).

Introduction of LIFE LOGOS 4 Waters and LIFE-MICACC projects

I have analysed two projects funded by the LIFE programme of the European Union and co-financed by the Hungarian State (Ministry of Interior), these projects are LIFE-MICACC and LIFE LOGOS 4 WATERS. The primary implementer of the project is the Ministry of the Interior, but they also work together with many organisations, such as WWF and the Association of Climate-Friendly Municipalities. The LOGOS project is focusing on natural water retention measures (NWRM), and one of their targets is to develop 20 small-scale NWRMs (Ministry of Interior, 2021). One of the goals of the project is to provide methodology for the Integrated Urban Water Management Plans. However, as this project is ongoing, there are no significant results so far (the project started in 2021 and will end in 2025), so I will present case studies from the LIFE-MICACC project, which also focused on NWRMs, but has already finished.

These projects have been included in the UN Partnership Platform, which states that the LIFE-MICACC project contributes to SDG 6 and SDG 13 (climate action). The project's title is "Municipalities as integrators and coordinators in adaptation to climate change" and it aims to improve the climate resilience of five vulnerable municipalities in Hungary through ecosystem-based NWRMs. They have created prototype projects to see if these solutions can be adapted and replicated in other Hungarian settlements. The project was successful, it has improved the climate resilience of the involved municipalities and made them more resistant to damage caused by water (Ministry of Interior, 2022). Monitoring was also carried out in the model plots with ecological and hydrological monitoring activities (Pataki et al., 2021). Throughout the implementation of the projects, particular attention was paid to communication and the continuous involvement of the residents.

The LIFE-MICACC project also invests heavily in improving ecosystem services (supply, cultural and regulatory services) (Ministry of Interior, 2021). Wetlands were created in all five municipalities involved, making the neighbourhood more liveable, providing recreational opportunities (e. g. fishing) and helping visitors to learn about climate change and sustainable water management solutions. I have chosen to analyse three case studies out of the five projects, because my goal was to present interventions with a particularly strong social impact.

The impact of SMWs on local communities in the light of LIFE projects based on expert interviews

To get a comprehensive picture of the impacts of SWMSs on local communities, I conducted two semi-structured expert interviews (in April 2023) with staff from the Association of Climate-Friendly Municipalities and analysed the case studies through these interviews. These experts are working as a project manager and a professional adviser and have been involved in several national sustainability-related projects. Local communities are given a special role in their work, and social consultation and education also fall within their remit. The Association is an active participant in the LIFE and LOGOS 4 Waters projects in Hungary, which adapt sustainable water management solutions, more specifically natural water conservation solutions. The main purpose of the interviews was to explore the social impacts of sustainable water management solutions

(which are under-represented in the scientific literature) through the experiences of the experts. My questions focused on the difficulties that local societies faced with water issues before the interventions presented, and the impacts of the interventions on local communities.

The expert interviews provided rich source of information on the social impacts of SWMSs. In Hungary, EU projects such as LIFE and LOGOS provide SWMSs for municipalities with a particular focus on natural water retention solutions. According to the interviewees, one of the most important benefits is that these solutions increase the sensitivity and awareness of the local community about environmental protection, generally through locally hosted events and locally distributed publications that raise public awareness about climate change and mitigation or adaptation options. This is line with the literature, which emphasises the necessity of education (Ostrom, 1990; Uphoff, 1992; Gleitsmann et al., 2007; Fernald et al., 2012; Spence et al., 2018). In the settlements involved, it can be observed that people are already experiencing climate change (they sense heat waves, the reduction in the volume of harvests in agriculture), even if they have limited knowledge about the causes. Local solutions also improve people's relationship with the landscape and their use of landscape through shaping the community's attitudes. It can also be observed among the population of the municipalities implementing the projects that the project has a local identity-forming effect, that is embedded in people's mental maps, and they feel more ownership of the developments than in the case of traditional water management solutions. This phenomenon is also supported by research that took place in 2015 (Czirfusz et al., 2015), which says that people's attitudes towards climate change depend heavily on the media, but personal perceptions have much greater power. Local identity and community resilience is correlated according to recent research in terms of environmental hazards (Sobhaninia et al., 2023) which makes this identity-forming effect extremely important.

Attitude formation also has a positive impact on the people's everyday habits. These habits include very basic changes in human behaviour; this change manifests, for example, through littering; the previously uninterested population no longer throws rubbish away, and even picks it up after others. This is also linked to the fact that the population is much more attentive to the developments that have been made with their involvement. It is also important to note that the relationship between water and population significantly improved in the involved settlements (underpinning the Kvassay Jenő Plan), in that people no longer see water as an asset or a threat, but as a value which needs to be preserved and protected. Consequently, water use is also improving, for example by reducing the use of piped water for irrigation and increasing rainwater collecting and retention at the properties. These practices also have a positive impact on people's budget, as watering with rainwater or well water is free of charge, so they can save on the cost of piped water.

Community building is also an explicit benefit of sustainable water management. During the implementation of the projects, there are several events involving local population organised by the Association or the Ministry of Interior. In addition to raising awareness, these events allow people express their views on local needs and developments, so they can easily get to know like-minded neighbours and start a discussion. This phenomenon is also supported by the literature, which says social capital is needed for decision-making processes, especially in environmental cases, and this social capital is generated through the events of the community (both formal and informal) (Ostrom, 1990; White and Runge, 1995). When the people are proud of the implemented projects, they will have the confidence to put pressure on decision-makers, and they are more likely to apply for further opportunities in the future. According to the interviews, mayors have a privileged role in adaptation and mitigation; if the mayors show the will to act, they are seen as a role model by the local population. The community experience is also built around the completed projects; when recreational spaces are created, people are keen to use them for leisure activities and participate in the maintenance activities.

The experts state that changes in the physical (built) environment also have a significant impact on the population and they will be willing to make physical changes on their own property. An example of this can be seen in cases where the aim is to preserve natural, green vegetation rather than completely artificially covered yards, as the benefits of green cover and permeable paving, for example against heat stress are recognised. These solutions, which can be done at home, improve biodiversity and provide a better living environment in a very simple way, which improves the general well-being of the population (Andrade et al., 2021).

Case studies on sustainable water management in Hungary

Bátya – Adapting to climate change by rainfall management

Bátya is a settlement of nearly 2000 inhabitants in the Kalocsa District. The area is one of the regions with the hottest temperature in Hungary (Pataki et al., 2021). The main problems in the area are periods of drought (which regularly damages local agriculture) and heavy rainfalls, so the solution is to store the water that falls during a heavy rainfall. A multi-basin stormwater reservoir with a capacity of 11,000 m³ has been created in the settlement, where a shallow area suitable for habitat has been created in addition to the permanent water surface (Veres et al., 2021). There is also a canal in the area that can be used for occasional water replenishment. Overall, local water supplies have increased, helping to bridge the gap between heavy rains and droughts.

The social impact of the project is significant. This is supported by the interviews and by a report on the socio-economic impact of the project (Számadó and Hügyecz, 2021). Perceptions of water have improved in the municipality and among the public, and the project significantly increased knowledge about climate change and SWMSs, which is in line with the importance of education (Fernald et al., 2021). Now the municipality has the knowledge to communicate a green approach on a longer term. Residents can sense the improvement in the local microclimate, biodiversity is increasing, and people are able to use the previously neglected area for recreation purposes, which has a beneficial effect on strengthening the social capital through informational events (White and Runge 1995; Weinberger and Jüttig, 2001).

Püspökszilágy – Adaptation to climate change with flood protection based on runoff slowing and water retention

Püspökszilágy is a village in Pest County with just over 700 inhabitants at the junction of the Gödöllő hills and Cserhát region, and there is also a watershed of the Danube and Tisza rivers (Pataki et al., 2021). The main problem of the village is that flash floods are an increased threat to the settlement and have caused a lot of material and financial damage to the residents over the years, but they also have to cope with periods of drought. Addressing both problems simultaneously means slowing down the run-off and creating a reservoir for rainwater. These solutions have helped to reduce the risk of flash floods in the village (there has been no water damage in the village since the project was implemented) and to supply water to a previously water-scarce area, thereby improving the microclimate.

Residents of Püspökszilágy are proud of the village's long-term thinking on climate change, which is an example for them and other municipalities (Számadó and Hügyecz 2021). The municipality has a very significant role in the awareness raising of residents; they are able to show them how to fight climate change and how to protect themselves from water damage and water scarcity. According to the interviews, local identity has been strengthened after the intervention through many formal and informal events in the town, which contributes to the increase of the community's social capital (White and Runge, 1995; Weinberger and Jüttig, 2001); the experts highlighted the strong personality of the mayor, who has a huge influence on the thinking of residents on climate change. The increasing biodiversity and the recreational opportunities have contributed to the well-being of the residents.

Tiszatarján – Sustainable management and riverside water retention for climate adaptation

Tiszatarján is located in Borsod-Abaúj-Zemplén County, along the river Tisza, in one of the most disadvantaged areas in Hungary, with a population of nearly 1400 inhabitants. The community is facing several challenges: inland flooding, droughts and river flooding are also problems in the village. They also have to contend with invasive plants, which both degrade biodiversity and reduce flood protection. The municipality also has a pond (Bivalyos tó), where the municipality grazes water buffaloes and there is significant aquatic vegetation (Veres et al., 2021; Pataki et al 2021). The aims of this municipality were to increase the bioenergy production, water retention, semi-natural grazing and promotion of ecotourism (Veres et al., 2021). To achieve these goals, they have created small-scale natural water retention solutions by creating open water surfaces in the floodplain. The solution involved the rehabilitation of the pond, increasing the water retention capacity in the area and reducing invasive plant species. A nature trail has been created around the pond to improve ecotourism, where a number of information panels have been installed. With the biomass produced sustainably in the area, the model has become economically sustainable and provides heating fuel for the municipality.

Residents' perception of the project is remarkably positive (Számadó and Húgyecz, 2021; Pataki et al. 2021). The project has given the municipality the motivation to look for new opportunities for the village to address sustainability and climate change. According to the interviews, the municipality is an active participant in the Association's activities. However, the municipality perceives that due to the disadvantaged situation of the area, it is much more difficult to transfer knowledge and communicate to the residents, which they want to solve by starting to shape attitudes among the children and continuously organising events on the topic. This is particularly important, because marginalised communities are extremely vulnerable to the effects of climate change (Otto et al., 2017; Patnaik, 2021). The new learning trail also offers an opportunity to shape the children's attitudes, where teachers are happy to take students to learn about nature, as they can get to know plants and animals up close. The trail has had a really good impact on local tourism; tourists like to visit the trail to see the buffalo as well as the natural environment. It makes the residents proud that they have been able to get involved in tourism along the Tisza, which is in line with the identity-forming role of the project.

Summary

SDG 6 deals with the management of water-related problems from among the sustainable development goals, but at the same time it must be seen that without its fulfilment, other goals are also unattainable, since water plays a significant role in all aspects of our lives. Water is also included in European planning documents, and local communities play an important role in both SDGs and European documents. In these documents, sustainable and integrated water management solutions are crucial, which can also be implemented as small-scale developments, and their great advantage is that they are also suitable for involving the local community. In Hungary, the main document for water affairs is the Kvassay Jenő Plan; the document is in line with the SDGs and main European regulations; however, it does not give as much emphasis to local communities as SDGs do.

Sustainable water management solutions are a great way to address water problems and handle climate change. These solutions allow all decision-making levels to be integrated into developments and help to implement environmentally friendly interventions. It is a significant fact that these solutions bring many benefits to the local community; according to the literature and expert interviews, they promote the acquisition of knowledge regarding both climate change and water use, they offer money-saving opportunities, they help make the living environment and the settlement more liveable, and they also provide recreational opportunities, all of which contribute to the well-being of the residents.

The presented case studies belong to the LIFE-MICACC project, which has also been added to the UN Partnership Platform, recognizing that it contributes to the fulfilment of SDG 6 and SDG 13, but we can observe this in the case studies. The case studies support the results of the literature analysis and the interviews, which say sustainable water management solutions can indeed improve the population's chances against climate change and improve local communities, not only the physical and natural environment. Based on the interviews and the literature, the municipalities involved in the project are much more likely to take steps against climate change and with the adapted small-scale solutions, the marginalised communities are also participating in the process through continuous involvement. The main lesson from the interviews is that the continued presence and education associated with the projects does indeed increase the local identity of the communities, social capital and community resilience. It is also important to recognise that mayors can act as role models for action on climate change. These characteristics make sustainable water management solutions suitable to contribute to the fulfilment of SDG 6.

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