CHALLENGES FOR METEOROLOGY IN THE SUSTAINABLE DEVELOPMENT GOALS (2015-2030)

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ABSTRACT. - Challenges for Meteorology in the Sustainable Development Goals (2015-2030). In September 2015 the General Assembly of the United Nations (UN) accepted the 2030 Agenda for Sustainable Development including 17 Sustainable Development Goals including 169 more detailed targets. These goals spread over all natural, societal and economical aspects of sustainability all over the world. The aim of our study is to specify those goals and detailed targets in which meteorology can and must play an important role. As concerns the complete Goals, this is only "Goal 13. Take urgent action to combat climate change and its impacts". At the level of detailed targets they are many ones in fulfilment of which meteorology should play a role. Having classified the meteorological contributions to the targets, there are four classes defined: air pollution (AP), climate information (CI), climate change (CC) and weather prediction. Altogether 26 targets of 16 Goals are found to be relevant to the meteorological activities. The possible contributions are all explained in the five groups in which the Goals are classified.

Keywords: *sustainable development, climate change, extremes, air pollution*

1. INTRODUCTION

In September 2015 the General Assembly of the United Nations (UN) accepted the 2030 Agenda for Sustainable Development including 17 Sustainable Development Goals (SDG, 2015) including 169 more detailed targets. These goals spread over all natural, human and economical aspects of sustainability all over the world. Those goals and sub-targets are specified in which environmental aspects are in the focus, or they play an important role. For each environment-related goals and sub-targets we present illustrations from the Hungarian statistics to point at the still actual problems, as well, as at those which are already solved.

There is no clear structure of the Goals comprehended in *Fig. 1*. One may suspect that the Goals of physical needs, key resources and landscapes in danger are intentionally mixed with those of technological and institutional character to present all the Goals as one unit. The first 15 Goals are related to all levels of society, whereas the last two are of rather global character. In the followings, we discuss contribution of meteorology in the above classification of the 17 Goals. The targets within them are only mentioned in case of relevance.

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Let us conditionally classify the 17 Goals into the following groups. Please, see SDG (2015) or the text later below for full wording of the Goals.

- Primary needs of humans (2. Food, 3. Health, 6. Water and 7. Energy)
- Equality between humans (1. No poverty, 4 Education, 5. Gender equality and 10. Reduced inequalities)
- Efficient, sustainable production (8. Economic growth, 9. Innovative industry, 12. Responsible consumption and production, 13. Climate action)
- Landscapes in danger (11. Cities, 14. Life in water and 15. Life on land)
- Worldwide cooperation (16. Peace and justice and 17. Partnerships)

Fig. 1. ***Icons of the Sustainable Development Goals (2016-2030)***

2. GOALS WITH RELEVANCE TO METEOROLOGY

In this Section we list the 17 Goals together with evaluation of contributions by meteorology. As concerns the targets, only those relevant to meteorology are listed in their quoted wording. Most targets contain quantitative and qualitative objectives. Another part of the targets point at organisation tools, as preconditions of the objective targets. As a rule, the previous ones are indicated by numbers (e.g. 1.1), and the latter ones by letters (e.g. 1.a). In the followings we focus on numbered targets, but in two cases we reflect at lettered ones, too. The ways how meteorology can contribute to these targets is presented here in tables marked its possible forms: Air pollution (AP), climate information (CI), climate change (CC) and weather forecasts (WF).

Before listing the targets, let us note that there is only one Goal in target of which we could not find any task for meteorology: *Goal 5. Achieve gender equality and empower all women and girls*

2.1 Primary needs of humans (4 Goals, 6 relevant targets)

Goal 2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture, target 2.4: By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help

maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality.

Goal 3. Ensure healthy lives and promote well-being for all at all ages, target 3.6: By 2020, halve the number of global deaths and injuries from road traffic accidents. *Target 3.9:* By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination. *Target 3.d:* Strengthen the capacity of all countries, in particular developing countries, for early warning, risk reduction and management of national and global health risks.

Goal 6. Ensure availability and sustainable management of water and sanitation for all, target 6.4: By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity.

Goal 7. Ensure access to affordable, reliable, sustainable and modern energy for all, target 7.2: By 2030, increase substantially the share of renewable energy in global energy mix.

Table 1. ***Meteorological contribution to targets related to primary human needs***

	Air pollution (AP)	**Climate information (CI)**	**Climate change (CC)**	**Weather forecasts (WF)**
Target 2.4		+	+	+
Target 3.6				+
Target 3.9	+	+		+
Target 3.d				+
Target 6.4		+	+	
Target 7.2		+		+

Reading along the lines of *Tab. 1* contribution of meteorology can contribute to them as follows. Sustainable food production (target 2.4) requires use of climate information (not only the means, but also interrelated spread along them and frequency distribution, including extremes). As between the year 2030 and the origin of available climate information there are several decades, projections of regional climate change are also useful. Finally, long-term weather prediction, not impossible at the lower latitudes, in connection with the El-Nino La-Nina fluctuation (see Fig 1) is also useful, whereas in everyday agricultural practice, even the weather forecast for several days ahead are also useful. Against the accidents (target 3.6) adequately tailored and distributed weather forecast on road conditions and visibility are especially useful. For decreasing illnesses of chemical origin (target 3.9), air chemistry knowledge is obviously required. Besides that, climate information on usual and extreme conditions for accumulation of various pollution types is of value. Finally weather prediction of e.g. smog conditions are especially needed for sick people and their doctors. Early warning systems related to the health risks (target 3.d) should obviously rely on weather forecasts, in cooperation with health authorities. Against water scarcity (target 6.4) both climate information and climate change regional projections are of unavoidable use. To

increase share of renewable energy (target 7.2) climate information is useful to assess the potentials and weather prediction of e.g. actual wind energy are relevant.

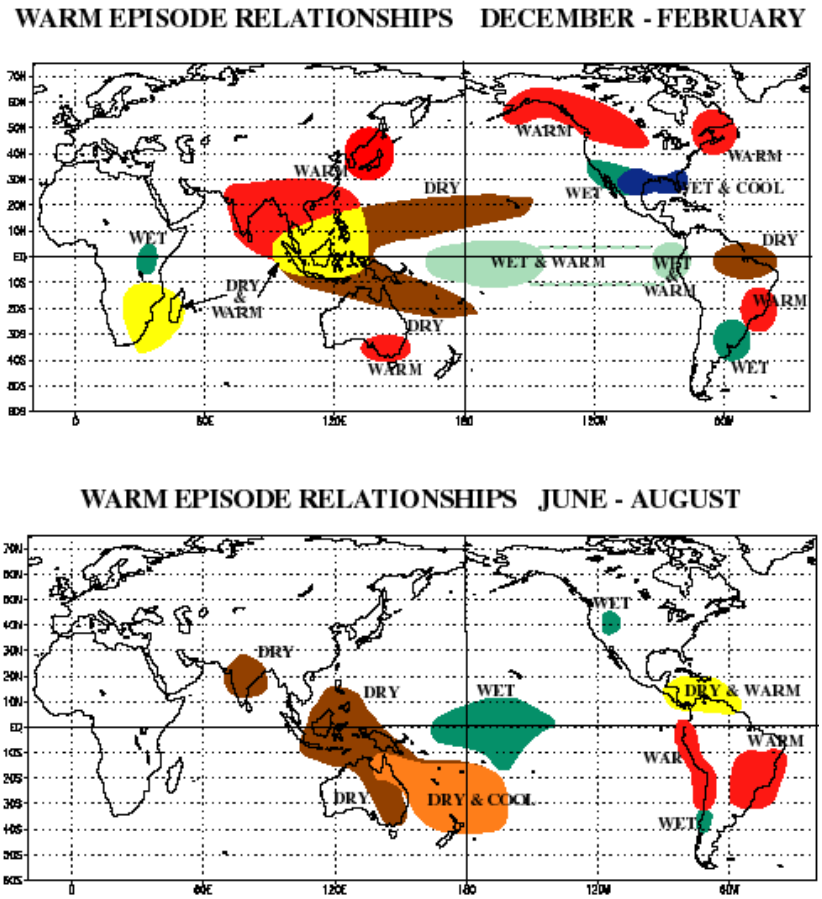

Fig. 2. ***Empirically established regional climate anomalies related to El-Nino episodes (Source, NCEP, NOAA, USA, http://www.wmo.int/pages/themes/climate/understanding_climate.php#c.)***

2.2 Equality between humans (3 Goals, 3 targets)

Goal 1. End poverty in all its forms everywhere, target 1.5: By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters.

Goal 4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all, target 4.7: By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights,

gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development.

Goal 10. Reduce inequality within and among countries, target 10.7: Facilitate orderly, safe, regular and responsible migration and mobility of people, including through the implementation of planned and well-managed migration policies.

Table 2. ***Meteorological contribution to targets related to equality between humans***

	Air pollution (AP)	Climate information (CI)	Climate change (CC)	Weather forecasts (WF)
Target 1.5		+		+
Target 4.7	+	+	+	+
Target 10.7		+		+

Not intended to explain all relevant cells of *Tab. 2*, let us emphasize only the full cells on target 4.7, i.e. education for sustainability. Everything, potentially provided by contemporary meteorology, can significantly contribute to key questions of sustainability, i.e. limited resources, pollution and environmental risks. It is important that existence and availability of these pieces of information should be distributed in all forms of education.

2.3 Efficient, sustainable production (4 Goals, 7 relevant targets)

Goal 8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all, target 8.4: Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead. *Target 8.9:* By 2030, devise and implement policies to promote sustainable tourism that creates jobs and promotes local culture and products.

Goal 9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation, Target 9.1: Develop quality, reliable, sustainable and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all.

Goal 12. Ensure sustainable consumption and production patterns, target 12.4: By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment. *Target 12.8:* By 2030, ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature.

Goal 13. Take urgent action to combat climate change and its impacts, target 13.1: Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries. *Target 13.3:* Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning.

In this group of Goals one may inquire why we can see only two targets of Goal 13, i.e. climate change listed as meteorology-relevant ones. But having read it in the SDG (2015), it one should understand that climate change is a much wider

problem even at the level of the sustainability targets, and a wider set of the targets has no meteorological aspects.

Table 3. ***Meteorological contribution to targets related to efficient production***

	Air pollution (AP)	**Climate information (CI)**	**Climate change (CC)**	**Weather forecasts (WF)**
Target 8.4		+		
Target 8.9		+		
Target 9.1		+		
Target 12.4	+			
Target 12.8	+	+		
Target 13.1		+	+	
Target 13.3	+	+	+	+

2.4 Landscapes in danger (3 Goals, 7 relevant targets)

Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable, target 11.5: By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations. *Target 11.6:* By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management.

Goal 14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development, target 14.1: By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution. *Target 14.5:* By 2020, conserve at least 10 per cent of coastal and marine areas, consistent with national and international law and based on the best available scientific information.

Goal 15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss, target 15.3: By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world. *Target 15.5:* Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species. *Target 15.8:* By 2020, introduce measures to prevent the introduction and significantly reduce the impact of invasive alien species on land and water ecosystems and control or eradicate the priority species (see Tab. 4).

As an example of wide variety of possible information let us have a look at *Fig. 3* surveying all weather-related extremes at global scale. As these landscapes are threatened by degradation at long time scales, most important contribution by meteorology is detailed climate information including smart interpolation. In some respects even climate change cab play role as planning is an activity for several decades ahead.

Table 4. ***Meteorological contribution to targets related to the landscapes in danger***

	Air pollution (AP)	Climate information (CI)	Climate change (CC)	Weather forecasts (WF)
Target 11.5		+		+
Target 11.6	+	+		+
Target 14.1	+			
Target 14.5		+	+	
Target 15.3		+	+	
Target 15.5		+	+	
Target 15.8		+	+	

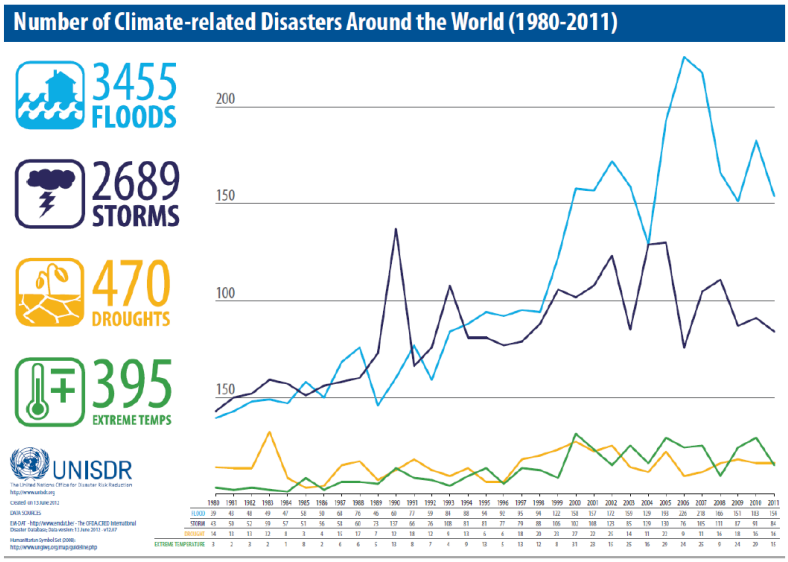

Fig. 3. ***Global time series of characteristic extremes of atmospheric origin***

2.5 Worldwide cooperation (2 Goals, 3 relevant targets)

Goal 16. Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels, target 16.8: Broaden and strengthen the participation of developing countries in the institutions of global governance. *Target 16.10*: Ensure public access to information and protect fundamental freedoms, in accordance with national legislation and international agreements.

Goal 17. Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development, target 17.7: Promote the development, transfer, dissemination and diffusion of environmentally sound technologies to developing countries on favourable terms, including on concessional and preferential terms, as mutually agreed.

Table 5. ***Meteorological contribution to targets related to worldwide cooperation***

	Air pollution (AP)	Climate information (CI)	Climate change (CC)	Weather forecasts (WF)
Target 16.8	+		+	
Target 16.10		+		+
Target 17.7		+	+	+

In this set of Goals relevance of meteorology is not so obvious. For target 16.8 the Conference of Parties is a good example, dealing with mitigation of and adaptation to climate change. Climate change projections play important role to attract the decision-makers' attention to the problem. The ozone depletion is another example limited by the Montreal Protocol and its amendments. Public access to climate and weather information is would also be of key importance. Finally, cooperation between countries coordinated by the WMO serves as example to target 17.7, including exchange of operational data, numerical predictions and instruments.

3. CONCLUSION

In the limited space we provided information on the Sustainable Development Goals (2016-2030) with special emphasis on those targets which are relevant to meteorology. From the 17 Goals there was only one without such relation. Ca. 15% of the 169 targets were identified as having relevant meteorological aspects. Most targets (21 from the 26) request climate information (CI). Climate change (CC) and weather forecast (WF) can be attached to 11-11 targets. A slightly smaller number, 7 targets can be supported by information on air pollution (AP).

At the end of the paper we would remark, again, that the 17 goals and 169 targets are officially announced. The 26 targets and evaluation of the four types of meteorological information is a result of the author's knowledge only.

REFERENCES

SDG, 2015: United Nations Resolution A/RES/70/1 of 25 September 2015. The Goals are contained in paragraph 51 (http://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E)