

# 34th Annual IGAC SSC Meeting and Visioning Exercise



28-31 October 2019 | Mexico City, Mexico

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Mexico City, Mexico

The 34th Annual IGAC SSC Meeting was held between 29-31 October 2019 at the National Autonomous University of Mexico (UNAM) in Mexico City, Mexico. Prior to the SSC meeting, a Visioning Exercise was held with the objective of discussing IGAC's present role and identifying its direction for the future. Participants and facilitator for the Visioning Exercise are as follows.



## Participants

Paul Beukes  
Jim Crawford (Co-chair)  
Lisa Emberson  
Louisa Emmons  
Greg Frost  
Christian George  
Michel Grutter  
Mark Lawrence  
Pieternal Levelt  
Megan Melamed (Director)  
Clare Murphy  
Jennifer Murphy  
Manish Naja  
Abdus Salam  
Hiroshi Tanimoto (Co-chair)  
Mei Zheng

## Facilitator

Bill Sharpe

## Rapporteur

Edit Nagy-Tanaka



Venue: *Unidad de Seminarios Dr. Ignacio Chávez at UNAM*

**THE MEETING WAS OPENED BY MEGAN MELAMED**, by saying that IGAC needed to review what it did and why, and what direction it should take in the future. Hiroshi Tanimoto added that the scientific landscape around the atmospheric chemistry community has been changing over the last decade, with cutting-edge fundamental science evolving and a linkage to global sustainability emerging. He said that the SSC started a discussion in 2017 on how it could best serve the community, and that it was now the right time to do a Visioning Exercise to help draw up a future direction for IGAC. He encouraged the participants to imagine atmospheric chemistry in 2050, have an open mind, and listen to the others in this Visioning Exercise. Next, Bill Sharpe introduced shortly the structure of the Visioning Exercise. He explained that his role in this exercise was to help identify participants' visions and collect ideas for the future direction of IGAC.

### **EXERCISE 1**

**To discuss in pairs what vision is and what it does in the participants' lives.**

After the team work, each participant raised some topics. Interestingly, most of the participants mentioned professional visions, with only a few mentioning visions relating to their personal lives.

Issues such as the following were mentioned.

- Particular visions in professional life (such as improving society in a certain country)
- Efforts towards improving science
- Bringing knowledge into action



## Visioning Exercise 2



- Working in a certain direction
- Living up to children's expectations for the future
- Ensuring a good environment for our children

Bill summarized the topics saying that a vision was not a plan, but an individual aspiration and that it was important to look for opportunities. Next, Exercise 2 was introduced.

### EXERCISE 2

To look individually at *Topics to Discuss Document* (Appendix 1) and find important challenges/points or some personal statement about the importance of atmospheric chemistry.

The following statements were identified.

- 1) Mankind and nature thriving on earth
- 2) More equitable access to resources
- 3) Structures and data for sustainable world
- 4) Broad collaborations across disciplines to solve the problems
- 5) Bringing a flowering of curiosity back into AC
- 6) Crossing border between scientists and people



Using Pattern Recognition to Identify Themes

- 7) Identifying challenges on regional basis for sustainable development
- 8) Growing AC in Africa and other less active regions
- 9) Connecting regional efforts to find global solutions for a healthy planet
- 10) IGAC plays a role in whole earth systems
- 11) Empowered humanity acts on knowledge
- 12) Prioritizing efforts to ensure a sustainable atmosphere
- 13) Making a difference wherever most needed
- 14) AC interconnected with science of environment, land, water
- 15) Curiosity and problem solving in balance
- 16) Higher public awareness of state of atmosphere locally / in real time

The next step in this exercise was to group these vision statements based on “pattern recognition”. Pattern recognition is very helpful when trying to generate themes in a material. Bill then connected the themes and grouped the participants’ statements of vision, asking the participants to modify the grouping if it didn’t make sense to them. Finally, after the participants’ modifications, three groups emerged that can be labeled as the following.

- Sustainable world and mankind (statements 1, 2, 3, 11, 12)
- Curiosity, challenge, and collaboration (statements 4, 5, 7, 8, 13, 15, 16)
- Interconnections between science and people (statements 6, 9, 10, 14)

This exercise was conducted to see the visions of the participants, to bring individual motivations and to explore how participants shared the vision. Following this exercise, Bill explained that when talking about the future, we had to deal with two things:

- Quality of the future and its uncertainty, and
- Agency, i.e. our ability to act and our assumptions.

Figure 1 shows the dimensions of the future, with the individual cells being defined as follows.

**Cell (1):** This is a world where we can make forecasts and we make plans based of those forecasts.

**Cell (2):** Roadmaps are to organize ways to work on the future. We bring the actors together to settle on a direction.

**Cell (3):** Scenario planning: making stories for the future that

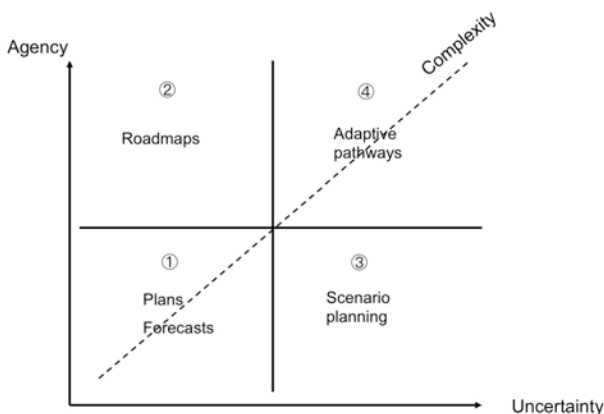
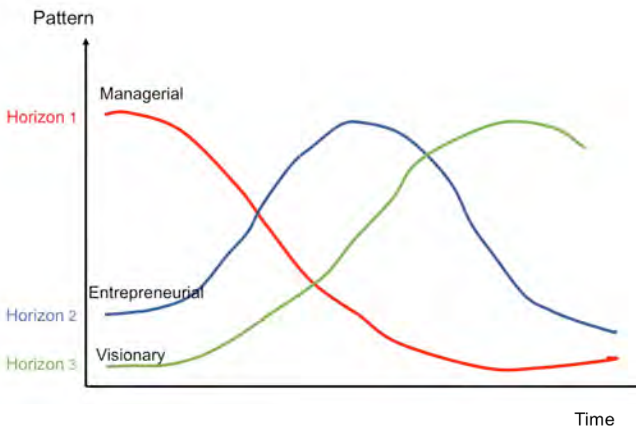


Figure 1  
Dimensions of the future



**Figure 2**  
Model of the Three Horizons

capture and hold critical uncertainties and help prepare us to handle different futures.

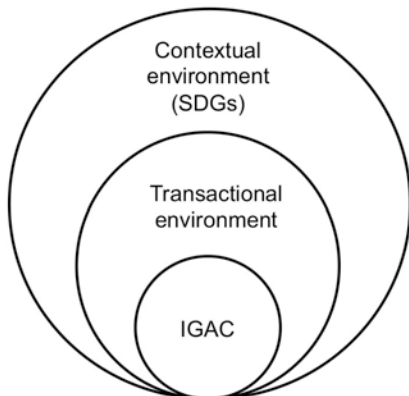
**Cell (4):** Adaptive pathways: only by taking steps we can learn, and learning leads to new steps forward which we adapt to the situation.

Next, Bill introduced the “Three Horizons Model” (Figure 2). The “Three Horizons Model” offers a simple but innovative way of looking at the future. It is a tool for thinking about transformation and how to bring it about. It helps groups to articulate a shared understanding of the current situation or system and their challenges (Horizon 1), visions for the future (Horizon 3) and the innovations that can help to achieve the future vision (Horizon 2). Learning to work with the Three Horizons Model enables groups to develop a shared language and to create transformational change that has a chance of succeeding.

**Horizon 1** Current situation of life that we reproduce by taking part in it.

**Horizon 3** Visions for the future, how we imagine the future.

**Horizon 2** Bridging H1 and H3 together, finding solutions and ways to implement them.



**Figure 3**  
Domains of an organization

The different horizons represent different views or mindsets. There is often strong disagreement between the horizons, for example, from the visionary point of view, the managers are lacking passion and they compromise our visions. We must recognize which of the voices/views we are using and recognize its values and limitations, and then we have to convene and find problem solving.

Bill continued the workshop by explaining the three domains of an organization (Figure 3).

**Inner domain:** the organization having a discussion. In the present case, IGAC.

**Middle domain:** transactional environment, the organizations IGAC deals with, all the organizations that participate in the discussion.

**Outer domain:** contextual environment, for example Sustainable Development Goals (SDGs) to frame the discussion. The SDGs are an aiming point to frame not only the needed actions, but



Working in pairs for  
Exercise 3



the direction of “travel” for a thriving humanity.

Bill explained that in this workshop the goal was to focus on actions, and that SDGs could be used as a proxy to frame the changing landscape of visions. Megan mentioned that IGAC already had conversations about SDGs and she wanted to bring this discussion into the workshop, but Bill emphasized that the goal for this workshop was to organize the participants’ thinking, not to find definitive solutions.

Next, Bill asked the participants to think about their own particular fields and identify what is good, then identify weaknesses and the elements that are not working well. This would be done through Exercise 3.

### EXERCISE 3

To review papers in *Impactful Examples Document* (Appendix 2) in pairs with regards to their contribution and find parallels to IGAC’s current situation. Aspects to consider were:

- Key actors
- Adjacent disciplines
- Translational structures
- What worked well?
- What is not fit for the future?



Vakkari, Kerminen, Beukes et al.: *Rapid changes in biomass burning aerosols by atmospheric oxidation*

- Good** • actual academic collaboration
- Weaknesses** • narrow scientific vision
- lack of translation of practical solutions
- missing actors: policy and politicians

Saturno, J. et al.: *Black and brown carbon over central Amazonia: Long-term aerosol measurements at the ATTO site*

- Good** • international collaboration
- scientific evidence combining areas
- robust and focused findings on black carbon
- addressing issues in adjacent disciplines
- Weaknesses** • not sufficiently interdisciplinary
- not translating to everyday life

SUSKAT field campaign in the Kathmandu Valley Special Issue

- Good** • wide range of scientists involved, bringing together MANGO
- capacity building of young scientists
- publication highlights issue in region
- Weaknesses** • modelling could not be done, lack capacity
- missing regional emissions data
- delay in scientific output (publication) compromised impact

UNEP-WHO: *Integrated assessment of black carbon and tropospheric Ozone + Shindell, D. et al.: Simultaneously mitigating near-term climate change and improving human health and food security*

- Good** • inspirational work across disciplines
- clear focus in complex issue
- WHO and UNEP acted as effective translators and messaging
- some success on national programmes
- Weaknesses** • practical issue not supported by ongoing science
- it took 25 years to bring climate change and atmospheric chemistry communities together

Bianchi et al.: *New particle formation in the free troposphere: A question of chemistry and timing + Ehn, M. et al.: A large source of low-volatility secondary organic aerosol.*

- Good** • hit several success criteria (right people together, different disciplines)
- inspired follow-up studies in other environments



- Weaknesses**
- triggered jealousy and fight (e.g. coal mine workers fighting for their jobs)
  - new generation of instrumentation needed
  - tomorrow's problems, not today's

National Academies of Sciences, Engineering and Medicine: *The future of atmospheric chemistry research: Remembering yesterday, understanding today, anticipating tomorrow.*

- Good**
- good for internal conversation amongst scientists
  - sustained IGAC funding

- Weaknesses**
- too technical, not reaching broader audience
  - lack of resources for implementation

*Korea-United States Air Quality Study (KORUS-AQ) Rapid Science Synthesis Report*

- Good**
- good model of broad collaboration and connection to policy makers
  - active mitigation measures supported
  - gave a voice to local actors

- Weaknesses**
- cultural differences diluted science and impact
  - local player wanted exclusivity
  - challenge from regional politics to science

Mills et al.: *Closing the global ozone yield gap: quantification and co-benefits for multi-stress tolerance*

- Good**
- good connection of disciplines, impact and concrete mitigation
  - good collaboration between atmospheric chemistry and agriculture
  - clear message accessible to the public

- Weaknesses**
- need to connect with agronomists
  - how reliable are these numbers?

The conclusion of this exercise was that although IGAC already was a multi-disciplinary organization, these papers proved how important it was to reach out to other disciplines, and to have international and multi-disciplinary collaborations.

After the lunch break, Bill said that exploring the first horizon generated some very general statements and problems. The next stage in this visioning exercise was exploring the vision of the third horizon. This would be achieved by looking at SDGs. How does IGAC address these goals? How can IGAC contribute to these goals? The SDGs can be seen not only as a means of problem solving, but also as aspirational goals.



Lunch Break

#### EXERCISE 4

To discuss 17 Sustainable Development Goals – SDGs Brief Description Document (Appendix 3).

Bill asked the participants to focus on an SDG and consider

- Key actors
- Adjacent disciplines
- Translational structures and processes
- What has been learnt from Horizon 1? How would IGAC align with SDG actions?

GOAL 1: Take urgent action to combat climate change and its impact (Pieterneel, Hiroshi, Louisa, Michel)

- Climate models need chemistry
- Better understanding of secondary aerosol formation & optical properties
- Prioritize SLCFs (O<sub>3</sub>, CH<sub>4</sub>, BC) + their role in climate
- Improve observation-based science including new techniques, e.g. satellites
- Mitigate emissions from fossil fuels for air quality and climate
- IGAC position paper to stress relevance of AC in climate

GOAL 2: End hunger, achieve food security and improved nutrition, and promote sustainable agriculture + 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 (Lisa, Jim, Manish, Jen)

Group discussions  
for Exercise 4



- Concentration & fluxes in agricultural regions
- Focus on data – poor food/insecure regions
- Land management and interactions with atmospheric chemistry
- Air quality & climate change impacts on ecosystem services
- Circulation & precipitation response to atmospheric composition
- Disruption to biogeochemical cycles

GOAL 3: Ensure healthy lives and promote well-being for all at all ages (Greg, Salam, Clare, Megan)

- Articulate/advocate for the role of AC in solving SDGs
- Be proactive vs reactive
- Improve models underpinning AQ early warning systems
- Support research + build capacity on indoor air quality
- Support fundamental AC and instrumental development for emerging issues
- Co-design of mitigation options for air quality and climate

GOAL 4: Ensure inclusive and equitable quality education and promote life-long learning opportunities for all (Mark, Mei, Christian, Paul)

- Why align?
  - 1) Responsibility
  - 2) Opportunity
  - 3) Survival
  - 4) Better students
- School education
  - Curricula
  - Teaching teachers
  - Relevance
- Educate society through the kids
- Education – critical public
- Better air quality – better learning (less illness/absence, better concentration)

Bill summarized the findings and said that the goal of this exercise was to see which activities and SDGs represented IGAC’s regular activities and how they were achieved. He presented Figure 4, indicating IGAC’s current focal activities.

**Figure 4**  
IGAC’s current focal activities.

Fostering community	
Building capacity	
Providing intellectual leadership	

However, in order for IGAC to evolve further, he said, it was necessary to incorporate individual visions (from the morning exercises) and find new categories of goals in addition to the ones in Figure 4. For this, Exercise 5 was conducted.

### **Exercise 5**

#### **To generate ideas for new IGAC activities/mission.**

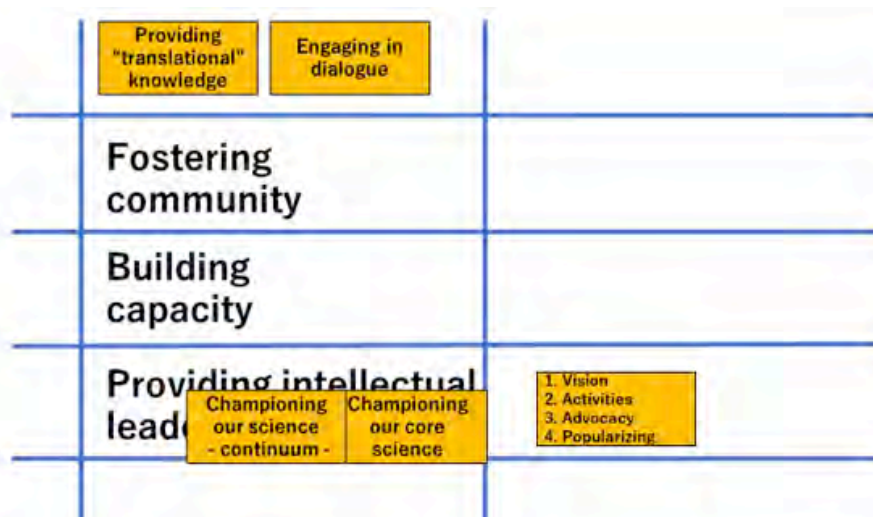
This exercise was characterized by a vivid discussion and brain storming. Issues like “How does the present framework allow us to break into new areas?”, “How do you ‘grow’ activities?”, “What does the IGAC SSC actually do?”, “What do we do to provide intellectual leadership?” arose in the discussion. Furthermore, questions like “Should the SSC have a stronger role?”, “Should the SSC assume new responsibilities?” were also raised. While the participants agreed that “Fostering community” and “Building capacity” were important responsibilities of IGAC, “Providing intellectual leadership” seemed to be more difficult to define. A participant suggested that IGAC rephrase this goal. The participants agreed that IGAC was quite successful in its mission, e.g. had well-supported conferences, but that IGAC probably didn’t manage to provide a clear message to policy-makers, politicians and stakeholders, and therefore, IGAC needed to have a clearer messaging of what it did and why (lobbying). A participant commented that IGAC shouldn’t confine itself to fundamental science as its main target and that IGAC should examine whether it had a clear objective. It was also mentioned that both visions and drivers were changing, and the question arose how IGAC navigated these changes and how it should communicate them to policymakers.



The following are some of the ideas for new IGAC activities suggested by the participants.

- Providing translational knowledge
- Translational efficacy
- Engaging in dialogue
- Championing science to the younger generation
- Championing our science
- Championing both outwards and inwards

A participant cautioned that the term “translational knowledge” was often used in medical sciences, and, therefore, in the atmospheric chemistry context the term should be rephrased and called “clear messaging”. An observation was that IGAC didn’t achieve what it wanted because it was not getting the message through. The participants agreed that IGAC had to communicate its goals differently to different groups, such as policymakers or scientists within and outside atmospheric chemistry. But first, it was important to find out what needs the different groups had in order to efficiently communicate IGAC goals to them. This required engaging in dialogue with different groups. Finally, the participants generated candidates for new activities/missions and added “Championing our science” and “Championing our core science” to the current goal of “Providing intellectual leadership”, as can be seen in Figure 5.



**Figure 5**  
Tentative new IGAC focal activities.

With regards to how these goals would be achieved, the participants suggested that “Championing our science/Championing our core science” could be achieved through:

- 1) Vision – basically an indication of how we champion our science
- 2) Activities – led by champions, not only leadership
- 3) Advocacy – or lobbying, to those who provide funding
- 4) Popularizing



The consensus was that IGAC needed to rephrase and/or expand its goals and communicate them more efficiently to better meet the needs of society. After this discussion, Exercise 6 was conducted.

### **EXERCISE 6**

**To connect the participants' individual visions with the IGAC goals.** The participants collected one sticker from Exercise 2 in the morning and pasted it in the figure cells on the board (Figure 5). The outcome of this exercise and the following discussion is as follows.

#### **Under "Providing translational knowledge" + "Engaging in dialogue"**

- Prioritizing efforts to ensure a sustainable atmosphere – we also have to talk with other communities and see how they address the problem (dialogue).
- Empowered humanity acts on knowledge
- Structures and data for sustainable world – we are good at getting activities together and getting more knowledge, but we need to be bolder in implementing them.
- Connecting regional efforts to find global solutions for a healthy planet – this can be achieved by connecting disciplines and communities.
- Crossing border between scientists and people – getting out our message more efficiently. Also, policy makers should come to the conferences to see what information and knowledge they can use to implement changes.
- Higher public awareness of state of atmosphere locally / in real time
- Broad collaborations across disciplines to solve the problems – atmosphere and

ocean communities should talk more to each other as both areas are important for a future Earth. There should be a broad communication between disciplines, we should be the communicators. Here, IGAC has an important role to play.

### At the interface of “Fostering community” + “Building capacity”

- Growing AC in Africa and other less active regions – Define priorities regionally and bring in curiosity, because different regions of the world do not have the same problems and developmental level.
- Making a difference wherever most needed
- More equitable access to resources – fostering community includes capacity building. It is important to address the main problems by allotting time and resources.

### Under “Building capacity”

- Bringing a flowering of curiosity back into AC
- Identifying challenges on regional basis for sustainable development – how can IGAC contribute?

### Under “Championing science”

- AC interconnected with science of environment, land, water
- IGAC plays a role in whole earth systems – emphasize IGAC’s unique role!
- Curiosity and problem solving in balance



One participant remarked that IGAC had to be bolder in the implementation of these activities. It was also mentioned that these kinds of activities will need more money and time, and it was suggested that SSC meetings could be conducted online, and the money for SSC meetings could be used for these kinds of activities. Bill summarized the results by saying that he found three key areas to be discussed with regards to the IGAC goals: deepening, broadening, and interface between goals. He suggested that the participants continued the discussion the following day to find a new focus for IGAC activities.

Exercise 6: Connecting Individual Visions to IGAC’s Focal Areas

The meeting was opened by Hiroshi Tanimoto, who summarized the last chart from the previous day (Figure 5). He said that IGAC needed to focus its activities and communication both within and outside the community and redefine its focal activities. He asked the participants to briefly summarize their impression of the discussions on the previous day and point out the most important issue to them in order to find topics for a potential new focus. The goal of today's meeting was to discuss these new focused activities and how they could be achieved. The following topics emerged. These groups correspond roughly to the ideas for new IGAC activities in Exercise 5.

### Exchange/dialogue

- We are members of other communities too – how to connect these different communities?
- Exchange with people.
- Engage in dialogue. It is a two-way process: we have to do more listening, what do they need and what can we do to achieve it? We have to meet others' needs.

### Messaging

- Clear messages to external communities – bottom-up or top-down?
- Direct our message to specific groups and adjust the language to them.
- We have many scientists in different fields – we need a group of people who have some understanding of all what we do – messaging.
- Having a science communication officer?

### Outreach/Championing our science

- SSC members need to attach themselves to activities
- We have to go to other conferences, e.g. health conferences.
- Invite IGAC people to hold a special session or presentation at conferences.
- IGAC's presence must be seen at other conferences – reaching out.
- Championing outside: organizing activities.
- IGAC should be more connected to regional activities and projects, e.g. inviting experts to organize summer schools.
- Branding and visibility are important.
- Get universities involved.
- Put money in education – IGAC-sponsored PhD?

### Future

- We are good at what we are doing but how can we demonstrate that we want to go on?
- Changing issues in the future. Where is the need to make greatest impact?
- We have to be more critical of ourselves, we have to be ready to change the way we do things.

### Financial issues

- Can we use IGAC money differently? E.g. off-conference SSC meetings online





*Visit to the Center  
of Atmospheric  
Science at UNAM*

- instead of meeting somewhere.
- Can IGAC fund projects in developing countries?
  - IGAC is not a funding organization. “Sponsored activity” is a misconception. Better to use the term “endorsed”, i.e. getting a stamp from IGAC that it is a necessary and sustained activity, so it will raise the chances of getting funding from elsewhere.

Bill’s advice for arriving at a new category of goals and missions for the future was “Disaggregate for understanding and aggregate for action”, i.e. break down the issue until you understand it, and then do something about it. He also acknowledged that using SDGs is one way to find a new mission but questioned whether SDGs were the best guidelines. He said that to accomplish a goal, a sustained view must be adopted, i.e. sustained actions and transformation. He suggested to continue the discussion in a session on 31 October.



*IGAC SSC members in front of the Central Library at UNAM*

Hiroshi Tanimoto introduced the day's program, which was to revisit the visioning exercises to find a new mission for the future. The current three focus areas are "Fostering community", "Building capacity", and "Providing leadership." All participants agreed that these three areas in general were good, but should be redefined by the SSC. It was also noted that a new focus area was needed in order for IGAC to achieve its mission. Hiroshi summarized the results of the previous exercises that resulted in the proposal of a new focus area, which could be called "Outreach and engagement", in addition to the existing ones. He also introduced the last exercise, Exercise 7.

### **EXERCISE 7**

**To review and rephrase the current three areas that IGAC focuses on to achieve its mission to facilitate atmospheric chemistry research toward a sustainable world, to draft a new focus area, and to renew the IGAC website with better vision definitions.** For this exercise, the participants split into groups for discussion,

after which each group presented its tentative revised definition. This was followed by a general discussion among all the participants, with suggestions for clarification, rephrasing and improvement. The final vision statements are the following.

**Advancing knowledge** (Jim, Chris, Manish, Salam)

This group suggested changing the existing mission title, “Providing intellectual leadership”, to “Advancing knowledge”, which was approved by all participants. The new definition is:

“IGAC provides a framework for scientific experts to convene at the international level, identify knowledge gaps and organize strategies to address them through topical activities that evolve with the state of knowledge. This is achieved by...”

**Fostering community** (Michel, Hiroshi, Jennifer)

“IGAC fosters collaborations across geographical boundaries, tackling shared challenges, enabling understanding, and connecting curiosity-driven science to applied research. This is achieved by...”

**Building capacity** (Mei, Judith, Louisa)

“IGAC supports equitable sharing of knowledge and resources to empower the current and next generation of researchers and scientific leaders. This is achieved by...”

**Engaging society** (the new focus area) (Pieterneel, Lisa, Paul, Greg, Clare)

The definition suggested by the group generated a heated discussion, some approving, some opposing and some discussing semantics, such as “conveying research results” (one-way communication) versus “engaging in dialogue” (two-way communication). Finally, Megan and Jim finalized the suggested definition and discussion, upon which all the participants agreed. The final definition is as follows: “IGAC aspires to develop the tools to synthesize and convey the relevance of atmospheric chemistry, and to promote dialogues with partners who can translate knowledge into action. We envision this will be achieved by...”

Everybody approved all the new definitions of the focal area statements. With this, the Visioning Exercise of the IGAC SSC was completed. Finally, the session was ended by closing remarks from Hiroshi Tanimoto and Jim Crawford, who thanked all the participants for their active contribution to discussing IGAC’s future. We hope this exercise will be a historic event with a lasting impact for IGAC and the international atmospheric chemistry community toward the future. ■

**Answer to the request to please provide any topics that you feel should be discussed as part of the visioning exercise and/or SSC meeting.**

#### FROM MEGAN AND CO-CHAIRS

- Should IGAC invite more liaisons?
- What is IGAC's relevance and how does it continue to get funding from the US for the IPO?
- Geoengineering
- Frontiers of science versus the application of science to define the problem globally
- How best to engage/build community in underrepresented areas (Africa, middle east, eastern Europe, Russia)
- Science-policy engagement
- Science-practitioner interactions
- The role of IGAC in fostering instrument/computing power exchanges
- Data collection and sharing within activities and working groups, is there a role for IGAC?

#### FROM SSC MEMBERS

- Balancing science with the emerging push for applied information ("Science for Services"), which some fear is going to marginalize fundamental science.
- We spend a lot of time discussing how to engage more closely with stakeholders and make our science more 'applicable to the real world'. But my understanding from some IGAC SSC members from e.g. south Asia is that in some parts of the world, the emphasis is only on the applied aspects of pollution and that they need help in advocating for being able to carry out 'fundamental science' studies. I think it would be useful to discuss this more and to consider whether IGAC could have a role to play in facilitating this.
- More in depth interaction of IGAC with other global core projects and Future Earth
- 1) Identify grand challenges of atmospheric chemistry, 2) Enhance effective international collaboration in atmospheric chemistry, and 3) Establish more programs for distinguished young scientists in atmospheric chemistry besides IGAC conference.
- 1) "Science to policy" in the atmospheric chemistry research: the framework of the approach and how we incorporate this dimension in the IGAC sponsored/endorsed activities. 2) Integrated research approach, especially considering the deposition fluxes of pollutants from the atmosphere to the Earth and subsequent impacts on the planet. This in turn will enhance the "Science to Policy" dimension and impacts of IGAC.
- Should IGAC seek sustained financial support from countries other than the US?
- 1) How to empower regional working groups, while keeping them intact with the IGAC?  
2) Encouragement of regional research vs global research?



- 1) Liaisons - whether we are willing to have CEOS community as a liaison? 2) WG - whether WGs can have their own projects?
- Air pollution affects the health of humans and ecosystems, as well as some important production sectors and food security. IGAC should discuss what role it should play in the broad international community, be active or rather passive, and discuss what our vision is in this regard. In the case we decide to be more active than we have been in the past, we could start an initiative to summarize relevant information for policy makers in an assessment which also could include some recommendations in the regional and local levels. Which are the trustworthy facts with respect pollution levels and evolution in different parts of the world, the known and accepted chemical processes for photochemical production of secondary pollutants, aging and transformations of aerosols, etc. are some topics which could be analyzed. No new information would be generated, but the facts from selected publications would be used and cited to give our view of the current situation. IGAC, being a group of experts in the field of atmospheric chemistry, could gain a lot of visibility with such a document and this could serve the broader community as well.
- Linking well-resourced groups with poorly resourced groups in order to enable atmospheric measurements/modelling in under-represented parts of the globe.
- 1) Modeling Capability 2) Mitigation based on Technology 3) Policy
- Beside purely scientific questions, we could discuss organizational issues (e.g., making sure all sub disciplines of atmospheric chemistry are aware of each other) and how to make the outcome of our visioning exercise known to stakeholders.
- How to stimulate the growth of the atmospheric research community in Africa and other, less active regions.
- Relationships between air quality and climate and ecosystems.

Answers to the request to please provide a reference from the last 5 years of an article, report, or other tangible output on atmospheric chemistry research that you consider successful and impactful. Why was it successful? How was it impactful to the world?

- **Korea-United States Air Quality Study (KORUS-AQ) Rapid Science Synthesis Report**, 2018, <https://espo.nasa.gov/sites/default/files/documents/KORUS-AQ-ENG.pdf>
  - My choice is a little self-serving, but it marks the first time in my career that a governing body wanted to know the results of our research and what they indicated about local air quality.
  - Hopefully it is helping to motivate emissions reductions in Asia, where air quality problems are currently most severe.
- National Academies of Sciences, Engineering, and Medicine. 2016. **The Future of Atmospheric Chemistry Research: Remembering Yesterday, Understanding Today, Anticipating Tomorrow**. Washington, DC: *The National Academies Press*. <https://doi.org/10.17226/23573>.
  - It represented thorough review and priority-setting from a diverse group of atmospheric chemistry researchers.
  - Not sure it was that impactful to the world, but it does offer guidance to policymakers and funding organizations, in addition to researchers.
- Saturno, J., Holanda, B. A., Pöhlker, C., Ditas, F., Wang, Q., Moran-Zuloaga, D., Brito, J., Carbone, S., Cheng, Y., Chi, X., Ditas, J., Hoffmann, T., Hrabce de Angelis, I., Könemann, T., Lavri, J. V., Ma, N., Ming, J., Paulsen, H., Pöhlker, M. L., Rizzo, L. V., Schlag, P., Su, H., Walter, D., Wolff, S., Zhang, Y., Artaxo, P., Pöschl, U., and Andreae, M. O.: **Black and brown carbon over central Amazonia: long-term aerosol measurements at the ATTO site**, *Atmos. Chem. Phys.*, 18, 12817-12843, <https://doi.org/10.5194/acp-18-12817-2018>, 2018.
  - Contributed to the understanding of Amazonian atmospheric aerosols in terms of their interactions with solar radiation and the physical and chemical-aging processes that they undergo during transport.
  - The understanding of all kind of processes affecting the Amazon is of great importance to the world to elucidate the complex interactions between the rainforest ecosystem and the atmosphere.
- Liu, M., Y. Song, T. Zhou, Z. Xu, C. Yan, M. Zheng, Z. Wu, M. Hu, Y. Wu, and T. Zhu (2017), **Fine particle pH during severe haze episodes in northern China**, *Geophys. Res. Lett.*, 44, 5213–5221, [doi:10.1002/2017GL073210](https://doi.org/10.1002/2017GL073210).
  - Aerosol acidity plays a very important role in atmospheric chemistry and in understanding formation mechanism of haze in China.
  - It leads to active discussion of various scientific questions including how to accurately measure aerosol pH and formation mechanisms of haze etc.
- Kim Oanh N.T., Permadi D. A., Hopke P. K., Smith R. K., Dong N. P. and Anh Nguyet D. (2018). **Annual emissions of air toxics emitted from crop residue open burning in Southeast Asia over the period of 2010–2015**. *Atmospheric Environment*. <https://doi.org/10.1016/j.atmosenv.2018.05.061>.
  - It presents a comprehensive method to develop emission inventory of crop residue open burning. Emissions were quantified showing how important this source of

- emissions is to local air quality, more than the forest fires in a number of countries. The source should be managed properly.
- It has been read by many. Several papers published by other researchers afterward follow the same methodology and used the set of emission factors compiled in the paper. The results are included in a policy brief delivered to policy makers to encourage measures to eliminate/minimize this emission source.
- UNEP-WMO (2011). **Integrated Assessment of Black Carbon and Tropospheric Ozone**, UNEP and World Meteorological Organization (WMO), Nairobi, Kenya. [ISBN: 92-807-3141-6](#).
    - It is among the most influencing documents but not within 5 years
    - Many projects on “co-benefits” and the whole CCAC has been created afterward.
  - McDonald, Brian & de Gouw, Joost & Gilman, Jessica & Jathar, Shantanu & Akherati, Ali & Cappa, Christopher & L Jimenez, Jose & Lee-Taylor, Julia & L Hayes, Patrick & McKeen, Stuart & Cui, Yuyan & Kim, Si-Wan & R Gentner, Drew & Isaacman-VanWertz, Gabriel & H Goldstein, Allen & Harley, Robert & Frost, Gregory & Roberts, J & B Ryerson, Thomas & Trainer, Michael. (2018). **Volatile chemical products emerging as largest petrochemical source of urban organic emissions**. *Science* (New York, N.Y.). 359. 760-764. [10.1126/science.aaq0524](#).
    - The work that informed this paper brought together a large number of researchers, led by a dynamic early-career scientist, with a variety of expertise and combined different types of datasets and methods. Its subject matter was accessible to a broad audience beyond the atmospheric chemistry research community. The paper received a lot of notice both from the scientific community and through popular media, so its findings could not be ignored by regulators and industry.
    - This article changed the way we think about the sources of urban air pollution. The paper has spurred new lines of atmospheric chemistry research inquiry, and it has changed the regulatory and policy communities’ ideas on urban pollution control strategies.
  - **SUSKAT field campaign in the Kathmandu Valley**, *Special Issue* [https://www.atmos-chem-phys.net/special\\_issue827.html](https://www.atmos-chem-phys.net/special_issue827.html).
    - South Asia, including the Indian Ocean, is not well understood and well-studied region in respect of Atmospheric Chemistry. SUSKAT field observation was a multi-national and multi institutional campaign that was conducted after about 20 years following the INDOEX campaign over the South Asia. It provided a good platform to experts in different domains of atmospheric chemistry to come together for the joint observations, followed by several joint publications. Now collaborations are continuing in the post-campaign period.
    - It has shown wide spread impact of the pollution to the remote regions. It has highlighted the existence of the diverse pollution sources at one place that impact a region. Such situation could be seen in very few regions of the world.
  - Shindell, D., J.C.I. Kuylenstierna, E. Vignati, R. van Dingenen, M. Amann, Z. Klimont, S.C. Anenberg, N. Muller, G. Janssens-Maenhout, F. Raes, J. Schwartz, G. Faluvegi, L. Pozzoli, K. Kupiainen, L. Höglund-Isaksson, L. Emberson, D. Streets, V. Ramanathan, K. Hicks, N.T.K. Oanh, G. Milly, M. Williams, V. Demkine, and D. Fowler, 2012: **Simultaneously mitigating near-term climate change and improving human health and food security**. *Science*, 335, 183-189, [doi:10.1126/science.1210026](#).

- They provided a clearer view to compare the importance of air pollutants with CO<sub>2</sub> in a time scale of 2050-2100.
  - Figure 1 of this paper is successful for public people to understand this complicated role of chemically reactive species in climate changes.
- Friedrich, Martina & Rivera, Claudia & Stremme, Wolfgang & Ojeda, Zuleica & Arellano, Josué & Bezanilla, Alejandro & Garcia-Reynoso, A & Grutter, Michel. (2019). **NO<sub>2</sub> vertical profiles and column densities from MAX-DOAS measurements in Mexico City.** *Atmospheric Measurement Techniques*. 12. 2545-2565. [10.5194/amt-12-2545-2019](https://doi.org/10.5194/amt-12-2545-2019).
  - This publication describes the development of a tool to analyze data from a network of instruments we have started to build more than 5 years ago to measure vertical columns of atmospheric gases. The success of the hard work from the many participants of this project is reflected in the data shown in this publication and the potential to understand temporal and spatial distribution of key pollutants such as NO<sub>2</sub> and HCHO.
  - Our data is being used by many international initiatives and projects for the validation of many satellite products from OMI and TROPOMI. We are also considered as a key player for the validation strategy of the TEMPO mission to be launched in the coming years by NASA.
- Bianchi, Federico & Trostl, J & Junninen, H & Frege, Carla & Henne, Stephan & Hoyle, Christopher & Molteni, U & Herrmann, Erik & Adamov, Alexey & Bukowiecki, N & Chen, Xuemeng & Duplissy, J & Gysel, Martin & Hutterli, Manuel & Kangasluoma, Juha & Kontkanen, Jenni & Kürten, Andreas & E. Manninen, H & Munch, S & Baltensperger, Urs. (2016). **New particle formation in the free troposphere: A question of chemistry and timing.** *Science*. 352. 1109-1112. [10.1126/science.aad5456](https://doi.org/10.1126/science.aad5456).
  - It used new measurement techniques in poorly sampled region and thereby identified some previously overlooked science.
  - The study also identified the impact of the new geophysical finding on the climate so that the importance of the finding was clear to readers of the paper.
- **Profile of Abdus Salam**, [http://www.du.ac.bd/faculty/faculty\\_details/CHM/112](http://www.du.ac.bd/faculty/faculty_details/CHM/112).
  - Our group is the pioneer in advanced atmospheric chemistry research in Bangladesh. We are able to characterize the chemical composition and identify the sources of atmospheric particulate matter. Government are able to find some solutions to solve the air pollution problem in Bangladesh.
  - Yes, our activities have significant impact to the world. E.g., Our AERONET AOD data are being used all over the world, especially at the remote Bhola Island.
- Ehn, Mikael & A Thornton, Joel & Kleist, E & Sipilä, Mikko & Junninen, Heikki & Pullinen, Iida & Springer, M & Rubach, Florian & Tillmann, Ralf & Lee, Ben & Lopez-Hilfiker, Felipe & Andrés, Saulo & Acir, I.-H & Rissanen, Matti & Jokinen, Tuija & Schobesberger, Siegfried & Kangasluoma, Juha & Kontkanen, Jenni & Nieminen, Tuomo & F Mentel, Thomas. (2014). **A large source of low-volatility secondary organic aerosol.** *Nature*. 506. 476-9. [10.1038/nature13032](https://doi.org/10.1038/nature13032).
  - In this paper they started to fill a gap in our understanding of organic aerosol formation and simultaneously underlined that many fundamental processes are still being unraveled. NB. There is a rapport of the US Academy of Science that suggest a few research orientations that might be interesting in our visioning exercise.
  - See above



- Vakkari, Kerminen, Beukes, et al., **Rapid changes in biomass burning aerosols by atmospheric oxidation**, *Geophysical Research Letters*, 41, 2644–2651, [doi:10.1002/2014GL059396](https://doi.org/10.1002/2014GL059396), 2014.
  - Cited by community (102 according to Scopus)
  - One of a number of papers by the same authors that indicate how frequent atmospheric new particle formation takes place in southern Africa (sA) and the effect thereof. The formation and growth rates of such secondary aerosols in sA being the most frequent and highest reported internationally. Secondary aerosols are important from air quality, human health, and climate perspectives. This and other associated papers help sensitize the internationally research community to this issue in sA and helped the South African government in decision making, e.g., legislation of precursor species.
- Mills, Gina & Sharps, Katrina & Simpson, David & Pleijel, Håkan & Frei, Michael & Burkey, Kent & Emberson, Lisa & Uddling, Johan & Broberg, Malin & Feng, Zhaozhong & Kobayashi, Kazuhiko & Agrawal, Madhoolika. (2018). **Closing the global ozone yield gap: Quantification and cobenefits for multistress tolerance**. *Global Change Biology*. 24. 1-26. [10.1111/gcb.14381](https://doi.org/10.1111/gcb.14381).
  - This paper sets yield losses due to air pollution (ozone) in the context of other key stresses to agricultural productivity (drought, soil fertility, pests, & diseases). Such context setting has not been done before at the global level. The paper also used the most recent risk assessment methodologies and identified particular global locations where air pollution was having an equivalent level of influence as the more recognized stressors (at least in relation to the agricultural community).
  - This paper helps assess the priority of air pollution for those concerned with food security and helps to assess vegetation impacts in a similar way to the ranking of air pollution impacts on human health in relation to other causes of global burden of disease. The impact of this kind of work will, I think, be increasingly realized over coming years/decades as air pollution continues to cause challenges in locations that may also increasingly suffer from other stresses. Understanding the interactions between these stresses will be important.

## OVERVIEW OF THE

# SUSTAINABLE DEVELOPMENT GOALS AND TARGETS

The United Nations' 2030 Agenda for Sustainable Development was adopted in September 2015. It is underpinned by 17 Sustainable Development Goals (SDGs) and 169 targets. National policymakers now face the challenge of implementing this indivisible agenda and achieving progress across the economic, social and environmental dimensions of sustainable development worldwide.

For a new report coordinated by the International Council for Science (ICSU), a team of scientists evaluated the key target-level interactions between an 'entry goal' and all other goals, and attributed a score to these interactions based on their expert judgment and as justified through the scientific literature.

The report is based on the premise that understanding the range of positive and negative interactions among SDGs is key to unlocking their full potential at any scale, as well as to ensuring that progress made in some areas is not made at the expense of progress in others. The nature, strengths and potential impact of these interactions are largely context-specific and depend on the policy options and strategies chosen to pursue them.

For the full report, go to: <http://bit.ly/sdg-interactions-guide>

**1.1** By 2030, eradicate extreme poverty for all people everywhere, currently measured as people living on less than \$1.25 a day

**1.2** By 2030, reduce at least by half the proportion of men, women and children of all ages living in poverty in all its dimensions according to national definitions

**1.3** Implement nationally appropriate social protection systems and measures for all, including floors, and by 2030 achieve substantial coverage of the poor and the vulnerable

**1.4** By 2030, ensure that all men and women, in particular the poor and the vulnerable, have equal rights to economic resources, as well as access to basic services, ownership and control over land and other forms of property, inheritance, natural resources, appropriate new technology and financial services, including microfinance

**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

**1.A** Ensure significant mobilization of resources from a variety of sources, including through enhanced development cooperation, in order to provide adequate and predictable means for developing countries, in particular least developed countries, to implement programmes and policies to end poverty in all its dimensions

**1.B** Create sound policy frameworks at the national, regional and international levels, based on pro-poor and gender-sensitive development strategies, to support accelerated investment in poverty eradication actions

**2.1** By 2030, end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round

**2.2** By 2030, end all forms of malnutrition, including achieving, by 2025, the internationally agreed targets on stunting and wasting in children under 5 years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women and older persons

**2.3** By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment

**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

**2.5** By 2030, maintain the genetic diversity of seeds, cultivated plants and farmed and domesticated animals and their related wild species, including through soundly managed and diversified seed and plant banks at the national, regional and international levels, and promote access to and fair and equitable sharing of benefits arising from the utilization of genetic resources and associated traditional knowledge, as internationally agreed

**2.A** Increase investment, including through enhanced international cooperation, in rural infrastructure, agricultural research and extension services, technology development and plant and livestock gene banks in order to enhance agricultural productive capacity in developing countries, in particular least developed countries

**2.B** Correct and prevent trade restrictions and distortions in world agricultural markets, including through the parallel elimination of all forms of agricultural export subsidies and all export measures with equivalent effect in accordance with the mandate of the Doha Development Round

**2.C** Adopt measures to ensure the proper functioning of food commodity markets and their derivatives and facilitate timely access to market information, including on food reserves, in order to help limit extreme food price volatility

**3.1** By 2030, reduce the global maternal mortality ratio to less than 70 per 100,000 live births

**3.2** By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births

**3.3** By 2030, end the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water-borne diseases and other communicable diseases

**3.4** By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being

**3.5** Strengthen the prevention and treatment of substance abuse, including narcotic drug abuse and harmful use of alcohol

**3.6** By 2020, halve the number of global deaths and injuries from road traffic accidents

**3.7** By 2030, ensure universal access to sexual and reproductive health-care services, including for family planning, information and education, and the integration of reproductive health into national strategies and programmes

**3.8** Achieve universal health coverage, including financial risk protection, access to quality essential health-care services and access to safe, effective, quality and affordable essential medicines and vaccines for all

**3.9** By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination

**3.A** Strengthen the implementation of the World Health Organization Framework Convention on Tobacco Control in all countries, as appropriate

**3.B** Support the research and development of vaccines and medicines for the communicable and non-communicable diseases that primarily affect developing countries, and provide access to affordable essential medicines and vaccines, in accordance with the Doha Declaration on the TRIPS Agreement and Public Health, which affirms the right of developing countries to use to the full the provisions in the Agreement on Trade-Related Aspects of Intellectual Property Rights regarding flexibilities to protect public health, and, in particular, provide access to medicines for all

**3.C** Substantially increase health financing and the recruitment, development, training and retention of the health workforce in developing countries, especially in least developed countries and small island developing States

**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

**4.1** By 2030, ensure that all girls and boys complete free, equitable and quality primary and secondary education leading to relevant and effective learning outcomes

**4.2** By 2030, ensure that all girls and boys have access to quality early childhood development, care and pre-primary education so that they are ready for primary education

**4.3** By 2030, ensure equal access for all women and men to affordable and quality technical, vocational and tertiary education, including university

**4.4** By 2030, substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship

**4.5** By 2030, eliminate gender disparities in education and ensure equal access to all levels of education and vocational training for the vulnerable, including persons with disabilities, indigenous peoples and children in vulnerable situations

**4.6** By 2030, ensure that all youth and a substantial proportion of adults, both men and women, achieve literacy and numeracy

**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

**4.A** Build and upgrade education facilities that are child, disability and gender sensitive and provide safe, non-violent, inclusive and effective learning environments for all

**4.B** By 2020, substantially expand globally the number of scholarships available to developing countries, in particular least developed countries, small island developing States and African countries, for enrolment in higher education, including vocational training and information and communications technology, technical, engineering and scientific programmes, in developed countries and other developing countries

**4.C** By 2030, substantially increase the supply of qualified teachers, including through international cooperation for teacher training in developing countries, especially least developed countries and small island developing States



## GOAL 5

### ACHIEVE GENDER EQUALITY AND EMPOWER ALL WOMEN AND GIRLS

- 5.1** End all forms of discrimination against all women and girls everywhere
- 5.2** Eliminate all forms of violence against all women and girls in the public and private spheres, including trafficking and sexual and other types of exploitation
- 5.3** Eliminate all harmful practices, such as child, early and forced marriage and female genital mutilation
- 5.4** Recognize and value unpaid care and domestic work through the provision of public services, infrastructure and social protection policies and the promotion of shared responsibility within the household and the family as nationally appropriate
- 5.5** Ensure women's full and effective participation and equal opportunities for leadership at all levels of decision-making in political, economic and public life
- 5.6** Ensure universal access to sexual and reproductive health and reproductive rights as agreed in accordance with the Programme of Action of the International Conference on Population and Development and the Beijing Platform for Action and the outcome documents of their review conferences
- 5.7** Undertake reforms to give women equal rights to economic resources, as well as access to ownership and control over land and other forms of property, financial services, inheritance and natural resources, in accordance with national laws
- 5.8** Enhance the use of enabling technology, in particular information and communications technology, to promote the empowerment of women
- 5.9** Adopt and strengthen sound policies and enforceable legislation for the promotion of gender equality and the empowerment of all women and girls at all levels

## GOAL 6

### ENSURE AVAILABILITY AND SUSTAINABLE MANAGEMENT OF WATER AND SANITATION FOR ALL

- 6.1** By 2030, achieve universal and equitable access to safe and affordable drinking water for all
- 6.2** By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations
- 6.3** By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally
- 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
- 6.5** By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate
- 6.6** By 2030, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes
- 6.7** 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
- 6.8** Support and strengthen the participation of local communities in improving water and sanitation management

## GOAL 7

### ENSURE ACCESS TO AFFORDABLE, RELIABLE, SUSTAINABLE, AND MODERN ENERGY FOR ALL

- 7.1** By 2030, ensure universal access to affordable, reliable and modern energy services
- 7.2** By 2030, increase substantially the share of renewable energy in the global energy mix
- 7.3** By 2030, double the global rate of improvement in energy efficiency
- 7.4** By 2030, enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology
- 7.5** By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States, and land-locked developing countries, in accordance with their respective programmes of support

## GOAL 8

### PROMOTE SUSTAINED, INCLUSIVE AND SUSTAINABLE ECONOMIC GROWTH, FULL AND PRODUCTIVE EMPLOYMENT AND DECENT WORK FOR ALL

- 8.1** Sustain per capita economic growth in accordance with national circumstances and, in particular, at least 7 per cent gross domestic product growth per annum in the least developed countries
- 8.2** Achieve higher levels of economic productivity through diversification, technological upgrading and labour-intensive sectors
- 8.3** Promote development-oriented policies that support productive activities, decent job creation, entrepreneurship, creativity and innovation, and encourage the formalization and growth of micro-, small- and medium-sized enterprises, including through access to financial services
- 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
- 8.5** By 2030, achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and equal pay for work of equal value
- 8.6** By 2020, substantially reduce the proportion of youth not in employment, education or training
- 8.7** Take immediate and effective measures to eradicate forced labour, end modern slavery and human trafficking and secure the prohibition and elimination of the worst forms of child labour, including recruitment and use of child soldiers, and by 2025 end child labour in all its forms
- 8.8** Protect labour rights and promote safe and secure working environments for all workers, including migrant workers, in particular women migrants, and those in precarious employment
- 8.9** By 2030, devise and implement policies to promote sustainable tourism that creates jobs and promotes local culture and products
- 8.10** Strengthen the capacity of domestic financial institutions to encourage and expand access to banking, insurance and financial services for all
- 8.A** Increase Aid for Trade support for developing countries, in particular least developed countries, including through the Enhanced Integrated Framework for Trade-Related Technical Assistance to Least Developed Countries
- 8.B** By 2020, develop and operationalize a global strategy for youth employment and implement the Global Jobs Pact of the International Labour Organization

## GOAL 9

### BUILD RESILIENT INFRASTRUCTURE, PROMOTE INCLUSIVE AND SUSTAINABLE INDUSTRIALIZATION AND FOSTER INNOVATION

- 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
- 9.2** Promote inclusive and sustainable industrialization and, by 2030, significantly raise industry's share of employment and gross domestic product, in line with national circumstances, and double its share in least developed countries
- 9.3** Increase the access of small-scale industrial and other enterprises, in particular in developing countries, to financial services, including affordable credit, and their integration into value chains and markets
- 9.4** By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities
- 9.5** Enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries, in particular developing countries, including, by 2030, encouraging innovation and substantially increasing the number of research and development workers per 1 million people and public and private research and development spending
- 9.A** Facilitate sustainable and resilient infrastructure development in developing countries through enhanced financial, technological and technical support to African countries, least developed countries, landlocked developing countries and small island developing States
- 9.B** Support domestic technology development, research and innovation in developing countries, including by ensuring a conducive policy environment for, inter alia, industrial diversification and value addition to commodities
- 9.C** Significantly increase access to information and communications technology, and strive to provide universal and affordable access to the Internet in least developed countries by 2020



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## GOAL 10 REDUCE INEQUALITY WITHIN AND AMONG COUNTRIES

- 10.1** By 2030, progressively achieve and sustain income growth of the bottom 40 per cent of the population at a rate higher than the national average
- 10.2** By 2030, empower and promote the social, economic and political inclusion of all, irrespective of age, sex, disability, race, ethnicity, origin, religion or economic or other status
- 10.3** Ensure equal opportunity and reduce inequalities of outcome, including by eliminating discriminatory laws, policies and practices and promoting appropriate legislation, policies and action in this regard
- 10.4** Adopt policies, especially fiscal, wage and social protection policies, and progressively achieve greater equality
- 10.5** Improve the regulation and monitoring of global financial markets and institutions and strengthen the implementation of such regulations
- 10.6** Ensure enhanced representation and voice for developing countries in decision-making in global international economic and financial institutions in order to deliver more effective, credible, accountable and legitimate institutions
- 10.7** Facilitate orderly, safe, regular and responsible migration and mobility of people, including through the implementation of planned and well-managed migration policies
- 10.8** Implement the principle of special and differential treatment for developing countries, in particular least developed countries, in accordance with World Trade Organization agreements
- 10.9** Encourage official development assistance and financial flows, including foreign direct investment, to States where the need is greatest, in particular least developing countries, African countries, small island developing States and landlocked developing countries, in accordance with their national plans and programmes
- 10.C** By 2030, reduce to less than 3 per cent the transaction costs of migrant remittances and eliminate remittance corridors with costs higher than 5 per cent

## GOAL 12 ENSURE SUSTAINABLE CONSUMPTION AND PRODUCTION PATTERNS

- 12.1** Implement the 10-year framework of programmes on sustainable consumption and production, all countries taking action, with developed countries taking the lead, taking into account the development and capabilities of developing countries
- 12.2** By 2030, achieve the sustainable management and efficient use of natural resources
- 12.3** By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses
- 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
- 12.5** By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse
- 12.6** Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle
- 12.7** Promote public procurement practices that are sustainable, in accordance with national policies and priorities
- 12.8** By 2030, ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature
- 12.A** Support developing countries to strengthen their scientific and technological capacity to move towards more sustainable patterns of consumption and production
- 12.B** Develop and implement tools to monitor sustainable development impacts for sustainable tourism that creates jobs and promotes local culture and products
- 12.C** Rationalize inefficient fossil-fuel subsidies that encourage wasteful consumption by removing market distortions, in accordance with national circumstances, including by restructuring taxation and phasing out those harmful subsidies, where they exist, to reflect their environmental impacts, taking fully into account the specific needs and conditions of developing countries and minimizing the possible adverse impacts on their development in a manner that protects the poor and the affected communities

## GOAL 13 TAKE URGENT ACTION TO COMBAT CLIMATE CHANGE AND ITS IMPACTS\*

- \*AcKnowledgeing** that the United Nations Framework Convention on Climate Change is the primary international, intergovernmental forum for negotiating the global response to climate change.
- 13.1** Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries
- 13.2** Integrate climate change measures into national policies, strategies and planning
- 13.3** Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning
- 13.A** Implement the commitment undertaken by developed-country parties to the United Nations Framework Convention on Climate Change to a goal of mobilizing jointly \$100 billion annually by 2020 from all sources to address the needs of developing countries in the context of meaningful mitigation actions and transparency on implementation and fully operationalize the Green Climate Fund through its capitalization as soon as possible
- 13.B** Promote mechanisms for raising capacity for effective climate change-related planning and management in least developed countries and small island developing States, including focusing on women, youth and local and marginalized communities

## GOAL 14 CONSERVE AND SUSTAINABLY USE THE OCEANS, SEAS AND MARINE RESOURCES FOR SUSTAINABLE DEVELOPMENT

- 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
- 14.2** By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration in order to achieve healthy and productive oceans
- 14.3** Minimize and address the impacts of ocean acidification, including through enhanced scientific cooperation at all levels
- 14.4** By 2020, effectively regulate harvesting and end overfishing, illegal, unreported and unregulated fishing and destructive fishing practices and implement science-based management plans, in order to restore fish stocks in the shortest time feasible, at least to levels that can produce maximum sustainable yield as determined by their biological characteristics
- 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
- 14.6** By 2020, prohibit certain forms of fisheries subsidies which contribute to overcapacity and overfishing, eliminate subsidies that contribute to illegal, unreported and unregulated fishing and refrain from introducing new such subsidies, recognizing that appropriate and effective special and differential treatment for developing and least developed countries should be an integral part of the World Trade Organization fisheries subsidies negotiation
- 14.7** By 2030, increase the economic benefits to Small Island Developing States and least developed countries from the sustainable use of marine resources, including through sustainable management of fisheries, aquaculture and tourism
- 14.A** Increase scientific knowledge, develop research capacity and transfer marine technology, taking into account the Intergovernmental Oceanographic Commission Criteria and Guidelines on the Transfer of Marine Technology, in order to improve ocean health and to enhance the contribution of marine biodiversity to the development of developing countries, in particular small island developing States and least developed countries
- 14.B** Provide access for small-scale artisanal fishers to marine resources and markets
- 14.C** Enhance the conservation and sustainable use of oceans and their resources by implementing international law as reflected in UNCLOS, which provides the legal framework for the conservation and sustainable use of oceans and their resources, as recalled in paragraph 156 of The Future We Want



## 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**

- 15.1** By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements
- 15.2** By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally
- 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
- 15.4** By 2030, ensure the conservation of mountain ecosystems, including their biodiversity, in order to enhance their capacity to provide benefits that are essential for sustainable development
- 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
- 15.6** Promote fair and equitable sharing of the benefits arising from the utilization of genetic resources and promote appropriate access to such resources, as internationally agreed
- 15.7** Take urgent action to end poaching and trafficking of protected species of flora and fauna and address both demand and supply of illegal wildlife products
- 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
- 15.9** By 2020, integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts
- 15.A** Mobilize and significantly increase financial resources from all sources to conserve and sustainably use biodiversity and ecosystems
- 15.B** Mobilize significant resources from all sources and at all levels to finance sustainable forest management and provide adequate incentives to developing countries to advance such management, including for conservation and reforestation
- 15.C** Enhance global support for efforts to combat poaching and trafficking of protected species, including by increasing the capacity of local communities to pursue sustainable livelihood opportunities

## GOAL 16

**PROMOTE PEACEFUL AND INCLUSIVE SOCIETIES FOR SUSTAINABLE DEVELOPMENT, BUILD ACCESS TO JUSTICE FOR ALL AND BUILD EFFECTIVE, ACCOUNTABLE AND INCLUSIVE INSTITUTIONS AT ALL LEVELS**

- 16.1** Significantly reduce all forms of violence and related death rates everywhere
- 16.2** End abuse, exploitation, trafficking and all forms of violence against and torture of children
- 16.3** Promote the rule of law at the national and international levels and ensure equal access to justice for all
- 16.4** By 2020, significantly reduce illicit financial and arms flows, strengthen the recovery and return of stolen assets and combat all forms of organized crime
- 16.5** Substantially reduce corruption and bribery in all their forms
- 16.6** Develop effective, accountable and transparent institutions at all levels
- 16.7** Ensure responsive, inclusive, participatory and representative decision-making at all levels
- 16.8** Broaden and strengthen the participation of developing countries in the institutions of global governance
- 16.9** By 2030, provide legal identity for all, including birth registration
- 16.10** Ensure public access to information and protect fundamental freedoms, in accordance with national legislation and international agreements
- 16.A** Strengthen relevant national institutions, including through international cooperation, for building capacity at all levels, in particular in developing countries, to prevent violence and combat terrorism and crime
- 16.B** Promote and enforce non-discriminatory laws and policies for sustainable development

## GOAL 17

**STRENGTHEN THE MEANS OF IMPLEMENTATION AND REVITALIZE THE GLOBAL PARTNERSHIP FOR SUSTAINABLE DEVELOPMENT**

### FINANCE

- 17.1** Strengthen domestic resource mobilization, including through international support to developing countries, to improve domestic capacity for tax and other revenue collection
- 17.2** Developed countries to implement fully their official development assistance commitments, including the commitment by many developed countries to achieve the target of 0.7 per cent of ODA/GNI to developing countries and 0.15 to 0.20 per cent of ODA/GNI to least developed countries; ODA providers are encouraged to consider setting a target to provide at least 0.20 per cent of ODA/GNI to least developed countries
- 17.3** Mobilize additional financial resources for developing countries from multiple sources
- 17.4** Assist developing countries in attaining long-term debt sustainability through coordinated policies aimed at fostering debt financing, debt relief and debt restructuring, as appropriate, and address the external debt of highly indebted poor countries to reduce debt distress
- 17.5** Adopt and implement investment promotion regimes for least developed countries

### TECHNOLOGY

- 17.6** Enhance North-South, South-South and triangular regional and international cooperation on and access to science, technology and innovation and enhance knowledge sharing on mutually agreed terms, including through improved coordination among existing mechanisms, in particular at the United Nations level, and through a global technology facilitation mechanism
- 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
- 17.8** Fully operationalize the technology bank and science, technology and innovation capacity-building mechanism for least developed countries by 2017 and enhance the use of enabling technology, in particular information and communications technology

### CAPACITY BUILDING

- 17.9** Enhance international support for implementing effective and targeted capacity-building in developing countries to support national plans to implement all the sustainable development goals, including through North-South, South-South and triangular cooperation

### TRADE

- 17.10** Promote a universal, rules-based, open, non-discriminatory and equitable multilateral trading

system under the World Trade Organization, including through the conclusion of negotiations under its Doha Development Agenda

- 17.11** Significantly increase the exports of developing countries, in particular with a view to doubling the least developed countries' share of global exports by 2020

- 17.12** Realize timely implementation of duty-free and quota-free market access on a lasting basis for all least developed countries, consistent with World Trade Organization decisions, including by ensuring that preferential rules of origin applicable to imports from least developed countries are transparent and simple, and contribute to facilitating market access

### SYSTEMIC ISSUES POLICY AND INSTITUTIONAL COHERENCE

- 17.13** Enhance global macroeconomic stability, including through policy coordination and policy coherence
- 17.14** Enhance policy coherence for sustainable development

- 17.15** Respect each country's policy space and leadership to establish and implement policies for poverty eradication and sustainable development

### MULTI-STAKEHOLDER PARTNERSHIPS

- 17.16** Enhance the global partnership for sustainable development, complemented by multi-stakeholder partnerships that mobilize and share knowledge, expertise, technology and financial resources, to support the achievement of the sustainable development goals in all countries, in particular developing countries

- 17.17** Encourage and promote effective public, public-private and civil society partnerships, building on the experience and resourcing strategies of partnerships

### DATA, MONITORING AND ACCOUNTABILITY

- 17.18** By 2020, enhance capacity-building support to developing countries, including for least developed countries and small island developing States, to increase significantly the availability of high-quality, timely and reliable data disaggregated by income, gender, age, race, ethnicity, migratory status, disability, geographic location and other characteristics relevant in national contexts

- 17.19** By 2030, build on existing initiatives to develop measurements of progress on sustainable development that complement gross domestic product, and support statistical capacity-building in developing countries



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