

The role of solidarity in pursuing the sustained improvement of people's living conditions and nature

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1. Introduction and Scope

We have to address a solidarity paradox: on the one hand there is so much solidarity exercised by individuals in families, hospitals, schools, communities, while on the other there are huge solidarity deficits between nations, and solidarity failures in tackling the global issues of people's poverty and destruction of our planet. We must find ways to overcome this micro versus macro paradox of solidarity, which poses a joint challenge for science and faith.

The following five important encyclicals form the foundations of this conference. They give guidance on how to address the global challenges of injustices, inequalities and exclusions, and how to consider living and consuming in a changing world.

- RERUM NOVARUM – on capital and labor (Pope Leo XIII, 1891)
- CENTESIMUS ANNUS – on the hundredth anniversary of RERUM NOVARUM with deep emphasis on solidarity (Pope St. John Paul II, 1991)
- CARITAS IN VERITATE – on integral human development in charity and truth (Pope Benedict XVI, 2009)
- LAUDATO SI' – on care for our common home (Pope Francis, 2015), and
- the new Encyclical FRATELLI TUTTI – on fraternity and social friendship (Pope Francis, 2020).

Together, these encyclicals span 130 years. Their sequence and thematic focus testify to the rapidly changing world and growing complexity of the challenges created by humanity, which are now impacting nature on a planetary scale in the Anthropocene epoch. During these 130 years science has progressed as never before in human history; violence has escalated into many unprecedented large wars and destructions, in particular the two world wars, the holocaust, and neglect leading to mass starvations; and nature and our fellow species are being destroyed by human activities at a scale like never before in human history, even putting humanity itself at risk due to climate crises.

The abovementioned encyclicals all have a significant contemporary social and natural science basis, connecting wisdom and knowledge, faith and science. That is why they can be used as important reference material from a science and a faith perspective to discuss potential actions for overcoming injustices, inequalities and exclusions. As Pope Benedict pointed out in CARITAS IN VERITATE "The Church's social doctrine ... allows faith, theology, metaphysics and science to come together in a collaborative effort in the service of humanity."

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In the following, I will first address concepts and different perspectives on solidarity. Then I will present new science in support of solidarity. I will elaborate on the role of solidarity in pursuing sustained improvement of people's living conditions, and protection and respect for nature to achieve global integral development.

2. Solidarity – religious, political, and philosophical perspectives

Solidarity comes from Latin "solidus". Solidus means solid, firm. "In solidum" described a debt relationship in which each and all are liable – i.e. there is a binding obligation, a joint debt. In Pope St. John Paul II's *Centesimus Annus*, the concept of solidarity is elaborated by referring to Leo XIII as "...an elementary principle of sound political organization, namely, the more that individuals are defenseless within a given society, the more they require the care and concern of others, and in particular the intervention of governmental authority. In this way what we nowadays call the principle of solidarity, the validity of which both in the internal order of each nation and in the international order ... is clearly seen to be one of the fundamental principles of the Christian view of social and political organization." (*Centesimus Annus*, 10).

Solidarity is of intrinsic value – expression of compassion, caring, charity – and solidarity is instrumental for human development, and at times instrumentalized. In political contexts "Solidarity" was used for celebration days in the Soviet Union and for movements in developing countries and many other events and organizations. The famous Solidarność trade union in Poland gave it recognition for workers' rights and freedom. In view of the multiple uses and loaded historical meaning of the term, some argued the word should be left for ceremonial speeches (Luhmann 1984). Yet, the concept has clear and important meaning.

For clarity's sake we need to separate its normative and positive concept. Habermas (1989) considers solidarity and justice to be two sides of the same coin, always internal to some concrete community, while universal morality and justice require detaching oneself from the internal bonds of concrete communities. In Habermas' concept solidarity is always a partial agent-driven "we thinking", while justice represents an impartial, agent-neutral perspective. However, it should be noted that the perspective of solidarity in CENTESIMUS ANNUS and even more so in FRATELLI TUTTI clearly goes beyond this narrow concept of solidarity as applicable to a particular, concrete community.

Such a broader solidarity concept is actually in line with Kant's concept of all persons forming a "Kingdom of Ends", derived from the categorical imperative. According to that view each individual has rights and duties and all individuals are one another's neighbors in a binding manner. While that may sound utopian, Rawls like Kant also considers universal duties toward other individuals and their wellbeing as integral requirements for human rights. This perspective actually overcomes an "us" versus "them" perspective. Rawls (1999) argues for a principled reconciliation of liberty and equality applying to the basic structure of a well-ordered society with principles of justice.² A complexity is that the "us" needs to include consideration of future generations in the sustainable earth environment. This matters for solidarity in the accelerating climate crisis. Thus Sen (2002) advocates a model of impartial arbitration, that can avoid the logical problem of a contract with future people.

² Rawls (1999) "Each person is to have an equal right to the most extensive total system of equal basic liberties compatible with a similar system of liberty for all". And "Social and economic inequalities are to be arranged so that they are both to the greatest benefit of the least advantaged, and attached to offices and positions open to all under conditions of fair equality of opportunity".

When it comes to practical implications, poverty is a clear indication of solidarity failures, at least in the sense of the broader concept as stipulated by Kant and FRATELLI TUTTI. Poverty remains high and has been growing in the Covid19 pandemic, and inequality is increasing in many countries. Compared to the time of RERUM NOVARUM, the labor versus capital distribution has rapidly evolved with a growing weight toward capital (Picketty 2015). The labor shares of income are declining, and capital shares of income are increasing, and consequently so is wealth inequality (ILO 2020).

But there are not only the poverty and inequality problems to consider when looking into symptoms and causes of solidarity failures. Against the backdrop of high poverty and growing inequality, the additional concept of *relative deprivation* is important. Relative deprivation is the comparison between the situation of an individual or group compared to others in society. Whereas absolute deprivation (poverty) is people's actual negative condition, relative deprivation is what people think they should have relative to what others have. While poverty in the world may change over time, relative deprivation will not, as long as social inequality persists and some are better off than others. The cause may be an unfavorable social position when compared to others, or discrimination such as racism or the envy that people may feel towards the wealthier portrayed in ("social") media. Relative deprivation undermines social cohesion and social peace. Relative deprivation increasingly matters in a globally informed urbanized world. Relative deprivation has important consequences for stress feelings and may activate collective action. It is a driver of migration (Stark 2020). If relative deprivation leads to social movements, the outcome may be positive collective action. Yet it may also lead to political violence and crime, if injustices persist.

3. How to address Solidarity deficits and the role of the sciences

Solidarity at scale requires collective action to facilitate overcoming the macro solidarity deficits. Collective action is needed and possible. Elinor Ostrom (2009) helped disprove the idea that, for instance, natural resources would necessarily be over-used and destroyed by selfishness in the long run. She disproved this idea by conducting field studies on how people in local communities manage shared natural resources, such as pastures and fishing waters in the US and Indonesia, and forests in Nepal. She showed that when common pool natural resources are jointly managed by their users, in time, rules are established for how these are to be cared for and used in a way that is both economically and ecologically sustainable. Her work emphasized the multifaceted nature of human-ecosystem interaction and argues for an understanding of social-ecological systems. Ostrom proposes some "design principles" of stable local common pool resource management, including internal trust and reciprocity; the appropriation and provision of common resources that are adapted to local conditions; mechanisms of conflict resolution that are cheap and of easy access; and self-determination of the communities; community recognized by higher-level authorities. Religious communities should aim to translate these social science insights from local levels to management of global commons, such as managing our common atmosphere. That needs global institutional arrangements and solidarity at a global level.

A set of action areas shall be elaborated below that can facilitate enhancement of solidarity. They are based on increasing bodies of science evidence. Therefore, I will first offer a few reflections on the roles of the sciences in this context, drawing on work by the Pontifical Academy of Sciences (von Braun and Sánchez Sorondo 2020): Although the large risks of global change are increasingly known and understood, appropriate responses to the Anthropocene's risks for planetary health are currently insufficient. Science has progressed in identifying these risks but needs to focus more intensively on working with society to finding and implement solutions that are equitable and just, and that acknowledge the inherent complexities of the tightly coupled systems of our planet. The

characteristics of innovations derived from science, however, partly determine their potentials to enhance solidarity. Thus, science is not neutral to outcomes in poverty, inequality and relative deprivation. Science must constantly earn the trust of society, otherwise it cannot enhance solidarity. The discourse between science and society will be endangered if equality of rights is not assured. Science at the service of solidarity must get involved in the political discourse, and drive changes needed to overcome injustices such as human trafficking, modern slavery and abuse. Five key areas for solidarity actions are presented here in which current and emerging science can foster sustainability of people and planet.

3.1 Solidarity in overcoming hunger and marginality, and their causes

Hunger is caused by poverty, marginality and exclusion, by environmental change and, increasingly, by violent conflicts. Different types of solidarity deficits are part of these root causes. The hunger of about 800 million people and the lack of access to healthy diets by about 3 billion people in the affluent world are symptoms of solidarity deficits at scale. Poverty, exclusion and marginalization of people are local and global solidarity failures. Focusing merely on the income dimensions of hunger and poverty will not address their root causes shaped by marginality. Marginality is the position of people at the margins, whose access to resources and opportunities, freedom of choice, and development of personal capabilities are prevented. The marginality framework helps to identify the opportunities of marginalized people, be they women, ethnic minorities, the disabled, or some otherwise excluded group. Especially in rural areas and small farming communities, ecosystem goods and services provide an important proportion of overall income and foundation of livelihoods. Recognizing the strong dependence of the marginalized poor on natural capital underlines the importance of policies intended to preserve the environment and natural resource bases for agriculture. The marginality framework sees social and ecological systems as coupled (von Braun and Gatzweiler, 2010). Economic and ecological approaches need to come together to comprehensively identify and address marginality patterns. Comprehensive coverage by social protection and basic social security with cash transfers, employment and nutrition components for all have become an important response to marginality in many African and Latin American countries. Achieving more resilience of the excluded in general requires overcoming exclusion in the first place. For the marginalized poor, direct public investment in resilience, such as basic health and nutrition and civic amenities, needs to come first in order to build the capabilities to engage for inclusion.

As the recent UN Food Systems Summit 2021 concluded, sciences and innovations are critical to accelerate the transformation toward healthier, more sustainable, equitable and resilient food systems including to increase productivity sustainably, adding income and nutrition components to social protection programs, and slashing food waste and losses. Research has found ways to restore soil health and improve the efficiency of cropping, breeding of crops, and re-carbonizing the biosphere. Protecting the land rights of smallholders, women and indigenous peoples is paramount. Alternative sources of healthy protein need to be advanced, including more plant-based proteins. Genetic engineering and biotechnology should be applied to increase productivity, quality and pest and drought resistance of crops. Traditional food and forest systems, including those of Indigenous Peoples, need to be better understood and supported in national agricultural research systems. Sharing these critically important science insights globally and with countries most in need is the required solidarity. Investing in sciences helps address the hunger problem but is too low. Even spending 1% of food system-related GDP – as called for at the recent UN Food Systems Summit – would change the hunger problem significantly, but many countries spend less.

In the world today much of the economy is dominated by growing inherited wealth. Piketty (2015) proposed that this should be addressed with a progressive annual global wealth tax. If the wealthy were actively facilitating that political change, it would be an act of solidarity. Redistribution of capital, however, is rare but can have positive effects for all. Malaysia offers an example. The polarization of Malaysian society along economic and ethnic lines fueled riots in 1969. Thereafter, the Malaysian government developed new policies in 1970 with a goal of poverty reduction for all, with an emphasis on reduction of ethnic economic imbalances. A major component of the New Economic Policy was affirmative action for Malays in the private and government sectors. Important was a policy of a national equity corporation supplying finances particularly to the relatively poor classes, such as housewives, farmers, and laborers, to hold shares in national and foreign companies. The overall effect of the new policy was improvement in the life of Malaysians, with poverty declining from about 49 percent in 1970 to 15 percent in 1990.

A prime task for solidarity is to preserve and enhance peace, as well as to avoid episodes of self-destruction, whether by war (hot or cold) or by environmental devastation. The high prevalence of violent conflicts in the world demonstrates a major solidarity deficit. Hunger is, to a growing extent, a consequence of violent conflicts, and violent conflicts are partly caused by hunger and misery. It is a two-way relationship. Violent conflict is destructive to all elements of the food system. Without food insecurity, it is difficult to build sustainable peace, and without peace the likelihood of ending global hunger is limited. By 2020, military spending had risen to its highest level since before the end of the Cold War, as had the international trade in weapons. Spending on arms is higher than on health and education. Solidarity for peace, and solidarity in multilateral disarmament would free up resources for sustainable development. States, community groups, local and international NGOs, religious communities, and United Nations agencies can create the conditions for food security and sustainable peace. Local level engagement for peace must identify potential causes for conflicts early, such as conflicts over land and water.

3.2 Solidarity to overcome climate crises and achieve sustainable consumption

The second global problem mentioned here will also not be overcome without solidarity at global scale. Climate change is an expression of a massive solidarity deficit. Caused by burning fossil fuels and other human activities it poses an existential threat to people and contributes to mass extinction of species. In addition, air pollution caused by the same activities is a major cause of premature death globally. Climate change and air pollution are closely interlinked because emissions of air pollutants and climate-altering greenhouse gases and other pollutants arise largely from humanity's use of fossil fuels and biomass fuels, with additional contributions from agriculture and land use change. The global environmental costs of food, for instance, add up to about 7 trillion US\$, which is approaching the same level as the market value of food (9 trillion US\$; Hendricks et. al. 2021).

An integrated plan to drastically reduce climate change and air pollution is essential. To accelerate decarbonization, there should be effective carbon pricing informed by estimates of the social costs of carbon, including the health effects of air pollution. The longer we wait to implement significant carbon taxes, the more the taxes will need to be raised later and be complemented with restrictions such as a faster-than-planned coal exit. Carbon prices of USD 50-100/tCO₂ by 2030 would be necessary in all countries to stay below 2°C rise. However, we need to be aware of potential equity implications of such carbon pricing. Carbon taxing all food commodities would increase malnutrition in Sub-Saharan Africa and South Asia, hence the need to tax selectively, and to protect the poor with social safety net policies.

The warming as well as the droughts caused by climate change, combined with the unsustainable use of aquifers and surface water, pose grave threats to the availability of fresh water and food security. Humanity can prevent catastrophic climate change while tackling the huge disease burden caused by air pollution and climate change by moving rapidly to a zero-carbon energy system (replacing coal, oil, and gas with wind, solar, geothermal, and other zero-carbon energy sources), by drastically reducing emissions of all other climate-altering pollutants, and by adopting sustainable land-use practices. An alliance with society that brings together scientists, policy makers, health care providers, faith/spiritual leaders, communities, and foundations should foster the societal transformation necessary to achieve our goals in the spirit of Pope Francis's encyclical *LAUDATO SI'*. The Faith and Science initiative for COP26 with its "Joint Appeal" by scientists and leaders from all main religions of the world is an important step of collective action in this direction.³

Addressing climate crises requires primarily recognition of the need to change consumption behavior, i.e. reducing consumption-related emissions and increasing sharing for investment in adaptation and in innovation. The global rich and middle classes know that fundamental changes in consumption behavior are needed. The starting point is the promotion of ethics in consumption, including sufficiency approaches. The concept of "enough" needs promoting. Faith-based organizations can play critical roles to get us there, especially engaging the youth. Cutting food waste will cut GHG emissions. Sustainable dietary patterns can lead to reductions as high as 70% of GHG emissions and land use, and 50% of water use in agriculture. Dietary shifts also yield benefits in health and mortality risks. School curricula need to help children understand complexity and interconnectedness of the ecological challenges that we are facing and empower them as agents of change. Governments must establish strong incentives for transition to a circular economy, including a bio-based economy. The whole set of instruments to trigger behavioral change needs to be adjusted to context, and must include information, education, nudging, targeted taxation, regulations and restrictions. The longer the necessary consumption transformation is delayed, the more we will need action to shift from soft approaches like information and education toward hard regulations and restrictions.

3.3 Solidarity with nature

Solidarity seems weak among people, and it is almost absent with regard to animals and the natural environment, but there are opportunities for enhancing solidarity, and the roles of sciences in that context. These issues are also relevant for people-animal relations. Rights-based approaches are increasingly expanded to animals – farm animals' welfare and wildlife – and protection of natural habitats for biodiversity and species conservation. Expanded nature reserves are a key element of protection by restricting land use. Including local communities in the benefits from nature reserves is critical for the sustainability of the latter.

Today, our common fascination with nature leads us to preserve species threatened by manmade environmental destruction, including climate change and the related loss of species, in zoological and botanical gardens. We understand that attempts to build "Noah's Arks for the 21st century" are not sufficient to prevent the threats of global loss of species by building and studying islands of protection. Still, the worldwide communities managing natural history museums, zoological and botanical gardens, and nature reserves and parks are significant allies in the global drive toward species protection and nature preservation on our planet.

³ <https://www.gov.uk/government/news/holy-see-faith-and-science-an-appeal-for-cop26> and <https://press.vatican.va/content/salastampa/en/bollettino/pubblico/2021/10/04/211004a.html>

The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) provides important information. We see a significant opportunity for international action in the UN Biodiversity conference COP15 2021/22 in China. The Convention on Biological Diversity (CBD) is dedicated to promoting sustainable development, with the goals of conserving biological diversity (all ecosystems, species, and genetic resources); sustainable use of the components of biological diversity; and the fair and equitable sharing of the benefits arising out of the use of genetic resources, notably those destined for commercial use. It has not, however, been particularly effective, with about a quarter of the world's tropical forests having been cleared since the CBD came into effect in 1993, and the very real threat that practically all such forests may be gone before the end of this century. The CBD's post-2022 global biodiversity framework must become more effective, particularly in facilitating cooperation between nations while enough time remains to save a major proportion of the world's existing biodiversity. It is good that themes such as Biodiversity and climate change, Biodiversity and agriculture, Biodiversity and health, Nature and culture have been placed on the agenda of COP15. However, the Biodiversity agenda must also become inclusive for people today and for future generations. Social justice, combined with a deep, sincere concern for one another, must form the basis for international conservation efforts if they are to succeed. All major world religions are committed to respecting and preserving nature and can agree on joint actions for this objective.

3.4 Solidarity for pandemic (Covid-19) management and vaccines

The COVID-19 crisis in principle put large parts of society at equal risks but in reality had very unequal outcomes, because of lack of solidarity. The pandemic has spotlighted inequities that put poor people in both low-income nations and in rich countries, at much greater risk of suffering. Pope Francis pointed at that, stressing "This is the moment to see the poor." The science communities were extremely fast in successfully developing vaccines, and corporations manufactured them quickly at scale. But in reality the global distribution of vaccines resulted in a big solidarity failure, with national priorities and even hoarding by richer nations, thus neglecting the poorer countries.

The COVID-19 paradox is that everybody, until they are vaccinated, needs to cooperate with others while simultaneously self-isolating as a protective measure. Yet, social distancing is quite feasible for wealthy people whereas poor people crowded in urban slums or refugee camps do not have that option, which is exacerbated by the fact that they lack masks and hand washing facilities. To address the risks in big crowded cities of developing countries, it became necessary to support prevention efforts by testing, using protective equipment, and building provisional hospitals to isolate infected people. Without access to responsible, transparent, and timely information, unproven assumptions spread through communities. What COVID-19 is also teaching us is that universal access to internet and communication technologies should be a human right. Unfortunately, these inequities lead yet to others in poor communities. COVID-19 is adversely affecting national economies, and is destroying small businesses and farmers. The disruptive consequences on food systems, especially, hurt poor people, who spend large shares of their income on food. This increases hunger and exacerbates the public health threat of the pandemic. COVID-19 has also exposed the fragility of interconnectedness. Curbing the rapid spread of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) required closing borders around infection hotspots. Human resources, equipment, knowledge about treatments, and supplies must be shared with poor countries. One could have expected that the pandemic affecting all would inspire solidarity, but nations looked inward, the rich ones in particular, and tensions, especially among the most powerful nations, increased too.

3.5 Solidarity and care when using digital technologies

A fifth area needs highlighting, as it is at the core of modernization and innovation in our age, which will fail to serve solidarity if not appropriately managed. Artificial intelligence (AI) and robotics are already significantly affecting the functioning of societies and economies. For instance, the emergent technologies have implications for medicine and health care, employment, transport, manufacturing, agriculture, and armed conflict. Privacy rights and the intrusion of states in one's personal life are major concerns. Attention to ethics is called for, because there are also long-term scenarios in AI/robotics with consequences that may ultimately challenge the place of humans in society. Of growing concern are risks of AI/robotics for peace, due to their enabling new forms of warfare such as cyber-attacks or autonomous weapons, thus calling for new international security regulations. Tapping the potential benefits of AI/robotics for equity, for the poor and marginalized requires management and regulations. AI and robotics need to be regulated under the Human Rights codex to protect people. Those who lose out due to AI/Robotics must be compensated.

Robots create new challenges for solidarity. Their spread profoundly modifies human and social relations in many spheres of society, in the family as well as in the workplace and in the public sphere. These modifications can take on the character of hybridization processes between the human characteristics of relationships and the artificial ones. Robot-robot and human-robot interactions are increasingly intensive, yet, AI systems are hard to test and validate. This raises issues of trust in AI and robots, and issues of regulation and ownership of data, assignment of responsibilities and transparency of algorithms, are arising, and require legitimate institutional arrangements. However, robots are instruments. "The primary sense is clearly that of not being a cause of itself or not existing by itself." (Sánchez Sorondo in von Braun, Archer, Reichberg, Sanchez Sorondo 2021. Chapter 14). As such, the artificially intelligent robot is a means at the service of humans. Advocating for the positive coexistence of humans and AI, Lee (in von Braun, Archer, Reichberg, Sanchez Sorondo (Eds.). 2021, Chapter 22) outlines a vision of a system that provides for all members of society, that also uses the wealth generated by AI to build a society that is more compassionate, loving, and ultimately more humane. It would put the economic bounty generated by AI to work in building a better society, and with strengthened solidarity.

4. Summarized conclusions

Solidarity has an intrinsic value as an expression of compassion, caring, and charity. It is instrumental for human development, and at times instrumentalized. The concepts of marginality and relative deprivation are important in identify the causes of solidarity deficits, because exclusion is a reality and because people more and more compare themselves with others in our urbanized, increasingly globally-informed world. Promising actions that may help enhance solidarity in five key areas of humanity and protection of nature are:

Solidarity to overcome hunger and marginality – requires the transformation to healthier, more sustainable, equitable and resilient food systems, including a sustainable increase in productivity, and adding income and nutrition components to social protection programs. Protecting the land rights of smallholders, women and indigenous peoples is paramount. Comprehensive coverage by social protection and basic social security with cash transfers, employment and nutrition components, and access to capital and finance to the relatively poor must be implemented.

Solidarity to overcome the climate crisis and achieve sustainable consumption – requires effective carbon pricing, while considering equity implications. The poor must be protected from the increase in the costs of basic needs at short notice. Fundamental changes in consumption behavior should start by promoting sufficiency and the concept of "enough". Instruments to trigger behavioral

change include information, education, nudging, targeted taxation, regulations and restrictions, and slashing food waste and losses.

Solidarity with nature and animals – requires putting an end to species extinction as quickly as possible by expanded nature reserves and changed land use. The UN Biodiversity conference COP15 2021/22 must focus on biodiversity protection without neglecting people that relate closely to natural environments, such as forests. Farm animals' welfare needs much more protection, too.

Solidarity in the management of pandemics – requires human resources, equipment, and, in particular, the sharing of vaccines with low- and middle-income countries. Sharing science and global collective action in science offer great opportunities. This requires solidarity among scientists and openness of governments to facilitate and not hinder such cooperation.

Solidarity and care when using digital technologies – requires wealth generated by AI and robotics to be used to build a society that is more compassionate and loving. We would have more time and energy to invest in care work, community services, and education. Standards to protect people's rights, such as the ones defined for human dignity in the UN Human Rights codex, must regulate AI and robotics. In all of these five action areas social science and natural science can play important roles, and solidarity makes a big difference, if facilitated at scale.

The world is globalized. Together, science and faith can and must address the solidarity paradox referred to at the beginning: the beautiful solidarities at the individual, family and community levels need to be scaled and translated to the macro level too, against all divisive political and economic odds. Science and faith should have complementary roles to achieve that.

5. References

RERUM NOVARUM – on capital and labor (Pope Leo XIII, 1891)

CENTESIMUS ANNUS – on the hundredth anniversary of RERUM NOVARUM (Pope St. John Paul II, 1991)

CARITAS IN VERITATE – on integral human development in charity and truth (Pope Benedict XVI, 2009)

LAUDATO SI' – on care of our common home (Pope Francis, 2015)

FRATELLI TUTTI – on fraternity and social friendship (Pope Francis, 2020).

FAITH & SCIENCE: toward COP26. 2021. <https://www.wiltonpark.org.uk/event/faith-and-science-towards-cop26/>

Habermas, Jürgen (1989) Justice and Solidarity. On discussion concerning stage 6. Philosophical Forum 21: 12, 32-52

ILO (2019). THE GLOBAL LABOUR INCOME SHARE AND DISTRIBUTION Data Production and Analysis Unit, ILO Department of Statistics Key Findings July 2019

Laitinen, Arto and Anne Brigitte Pessi (2015) Solidarity – Theory and Practice. Lexington Books. London

Luhmann, Niklas (1984) Die Differenzierung von Interaktion und Gesellschaft. Probleme der sozialen Solidarität. In: Solidarität in der Welt der 80er Jahre: Leistungsgesellschaft und Sozialstaat. ed. R.Kapp. Frankfurt. Helbig & Lichtenhain. 76-96.

Ostrom, Elinor (2009) A General Framework for Analyzing Sustainability of Social-Ecological Systems. SCIENCE. 24 Jul 2009. Vol 325, Issue 5939, pp. 419-422. DOI: 10.1126/science.1172133

Piketty, Thomas (2015). About Capital in the Twenty-First Century. AMERICAN ECONOMIC REVIEW. VOL. 105, NO. 5, MAY 2015 pp. 48-53

Pontifical Academy of Sciences. 2020. Responding to the Pandemic, Lessons for Future Actions and Changing Priorities. <http://www.pas.va/content/accademia/en/events/2020/coronavirus.html>

Rawls, John (1999). *A Theory of Justice: Revised Edition*.

Science and Innovations for a Sustainable Food System – Preparing for the UN Food Systems Summit 2021. Pontifical Academy of Sciences.

Sen, Amartya (2002) Justice across Borders, in Global Justice and Transnational Politics, eds. Pablo De Greiff and Ciaran Cronin (Cambridge: Cambridge University Press, 2002), 45-46.

von Braun, J., Archer, M.S., Reichberg, G.M., Sanchez Sorondo, M. (Eds.). 2021. Robotics, AI, and Humanity – Science, Ethics, and Policy. Springer Publ. New York. Free download: <https://www.springer.com/gp/book/9783030541729>

von Braun, J., F. Gatzweiler (Eds.). 2014. *Marginality – Addressing the Nexus of Poverty, Exclusion and Ecology*. Springer Netherlands. <http://link.springer.com/book/10.1007%2F978-94-007-7061-4>

von Braun, Joachim, M. Sánchez Sorondo (ed.) 2020. Transformative Roles of Science in Society: From Emerging Basic Science Toward Solutions for People's Wellbeing. Proceedings of the Plenary Session. 12-14 November 2018. Acta 25 Vatican City 2020

von Braun, Joachim, T. Kauffels, P. Raven, J. Vogel, M. Sánchez Sorondo (ed.) 2020. Science and Actions for Species Protection. Noah's Arks for the 21st Century. Proceedings of a Workshop 13-14 May 2019. Scripta Varia 146. Vatican City

von Braun, J. (2021) Wissenschaft für Fratelli Tutti – Empfehlungen der päpstlichen Akademie der Wissenschaften. In: Walter Kardinal Kasper und George Augustin (Hg.) Soziale Freundschaft Grünewald Verlag. Ostfildern. pp 222-235

Wael K. Al-Delaimy, Veerabhadran Ramanathan, Marcelo Sánchez Sorondo (2020) Health of People, Health of Planet and Our Responsibility – Climate Change, Air Pollution and Health. Springer Publ. (and Pontifical Academy of Sciences)