The importance of socioeconomic conditions in mitigating climate change impacts and achieving Sustainable Development Goals

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Abstract
Actions tackling with climate change can cause co-benefits and trade-offs with Sustainable Development Goals (SDGs) concerned with air pollution, water scarcity, food security, land use, and sustainable energy. Such interactions can be greatly influenced by socioeconomic conditions. The impacts of socioeconomic conditions on multiple SDGs have not been evaluated separately from climate policies. This paper employs a Representative Concentration Pathways–Shared Socio-economic Pathways (RCP-SSP) framework and the Asia-Pacific Integrated Model/computable general equilibrium (AIM/CGE) integrated assessment model to identify the global multi-sectoral consequences of socioeconomic conditions through 2050 under future SSP scenarios. Results show that changes of socioeconomic conditions consistent with the SSP1 pathway could always improve SDG indicators, with or without climate policies. In many respects, socioeconomic conditions are more important than climate policies in achieving SDGs, particularly SDGs concerned with food security and energy affordability, as well as in simultaneously achieving multiple SDGs. We conclude that the advantages of a joint effort to implement climate policies and promulgate socioeconomic changes should be recognized by policy makers.

1. Introduction
The United Nations established Sustainable Development Goals (SDGs) in 2015. The SDGs include 17 goals and 169 targets that include, inter alia, eradication of poverty and hunger, access to clean air and water, use of sustainable energy, and mitigation of the impacts of climate change. There is an increasing need to implement all of these SDGs and targets because an overarching vision articulated by the SDGs was to ‘leave no one behind’ [1], and the SDGs interact with one another. Policy makers balance the interests and trade-offs that arise from the interactions between different goals so that the related policies can be effectively implemented [2].
Climate actions, like the carbon pricing policies included in SDG13, can cause co-benefits and trade-offs between climate policies and other SDGs [3, 4]. The co-benefits include air quality improvement [5] due to the phasing out of fossil fuels and greater energy security [6] due to new investments in clean energy technologies. The trade-offs include land...
management issues such as competing demands for land to produce food crops versus scaling up of bio-
mass production for use as low-carbon energy sources [7]. Fujimori et al [3] have recently estimated that a 1% reduction of carbon emissions could lead to a 0.57% reduction of air pollution-related premature deaths but could cause a 0.026% decrease of mean species richness.

Interactions between climate-related actions and SDGs could be greatly influenced by socioeconomic conditions, which incorporate demographic, societal, and technological development as well as governmental performance. Recent studies have explored socioeconomic conditions that individually influence aspects of sustainability. Examples include impacts on both climate change (e.g. mitigation costs [8]) and other SDGs related to water [9, 10], air [11], and hunger [12]. Complementary policies that impact both socioeconomic issues and climate should be implemented together. For example, to mitigate the negative impacts of climate policies, policies related to forest protection and food supplies should be implemented together with carbon-pricing policies [13].

Concerns have been raised about the respective roles of societal change and climate policies on climate mitigation in the context of sustainable development. Van Vuuren [14] has assessed alternative pathways to limit the global average temperature rise to no more than 1.5 °C, some of which involve critical societal changes such as lifestyle changes and low population growth. These alternatives benefit other SDGs. Grubler [15] has explored a low-energy-demand (LED) scenario that involves assumptions such as high-energy-efficiency end-use devices, dietary changes, improvements of material efficiency, reduced energy demand through digitalization, and device convergence. This scenario assumes that a high quality of life and high levels of energy services can be achieved while maintaining low energy demand. This LED scenario also identifies benefits with respects to health, air quality, and land use while keeping the temperature increase within the 1.5 °C limit.

These assessments of socioeconomic conditions have used long-term global scenarios, and related publications have recently begun to appear [16–19]. In these scenarios, the role that socioeconomic conditions play has not been separately evaluated. Quantitative and comprehensive assessment of the impact of socioeconomic conditions on multiple SDGs has been lacking.

Global climate change mitigation scenarios have recently been built on socioeconomic assumptions based on so-called Shared Socio-economic Pathways (SSPs) [20]. SSPs have many roles, one of which makes it possible to independently address climate policy and socioeconomic considerations. Moreover, in conjunction with Representative Concentration Pathways (RCPs), which determine the stringency of climate mitigation in terms of radiative forcing, the RCP-SSP framework has been intensively used [21] in the fields of climate mitigation, impact assessment, adaptation, and vulnerability. So-called SSPs scenarios have been used to represent different levels of difficulty of mitigation and adaptation in the development of societies. SSPs can also be used to represent possible pathways of societal change that lead to different sustainability statuses [22]. Five narratives have been developed to emphasize different trends of global and regional development. SSP2 assumes socioeconomic development consistent with historical patterns. SSP3 assumes a high level of mitigation and adaptation challenges. SSP4 features the inequalities among regions. SSP5 is taking the high way with extensive use of fossil fuels. SSP1 assumes that the society develops in accord with a consistent storyline that envisions simultaneous achievement of high levels of education, low rates of population growth, rapid economic growth, rapid rates of technological improvements, sensitivity to environmental issues, and sustainable patterns of production and consumption [23]. Among the five SSPs, SSP1 is designed to be a pathway of green growth that can help societies achieve more SDGs [24].

In this paper, we outline the multi-sectoral consequences of various socioeconomic conditions in the world by using the Asia-Pacific Integrated Model/computable general equilibrium (AIM/CGE) model and simulating future SSPs scenarios with or without climate policies through 2050. We compare a set of selective SDG-related indicators under scenarios that differ with respect to climate policies and societal conditions. Our objective is to identify the important roles that changes of socioeconomic conditions can play in achieving climate goals from the perspective of sustainable development and to contrast those roles with the role of climate policies.

This paper extends the RCP-SSP framework by incorporating the performances of multiple SDGs. This framework enables us to explore the separate roles of socioeconomic conditions and climate policies in determining the important implications of sustainable development for human beings and Earth systems. The results of the assessment may provide rationales for policy makers to pursue societal changes as a means of mitigating climate change impacts and as tools for promoting sustainable development. Moreover, the assessment and comparisons of scenarios helps us to rethink a strategy for simultaneously achieving climate goals and societal goals.

2. Methodology

2.1. The AIM/CGE model

The AIM/CGE model is a global-scale recursive, dynamic, CGE model that includes 42 industrial classifications. The energy sectors, including the power sectors, are disaggregated. The disaggregated energy
Table 1. SDG-related indicators.

| SDG aspects          | Indicators                       | Calculation                                                                 |
|----------------------|----------------------------------|-----------------------------------------------------------------------------|
| Energy security      | TPES diversity                   | $Q_i \times \ln(Q_i)$, where $Q_i$ is share of each type of primary energy in total primary energy supply (TPES) |
| Energy affordability | Electricity price                | Aggregated world electricity price at the secondary level                   |
| Air quality          | $SO_2$ emission                  | $SO_2$ emissions per year                                                  |
| Air quality          | $NO_x$ emission                  | $NO_x$ emissions per year                                                  |
| Air quality          | Black carbon (BC) emission       | BC emissions per year                                                       |
| Food security        | Food price                       | Consumer price of non-energy crops and livestock                           |
| Food security        | People at risk of hunger         | People at risk of hunger                                                    |
| Land management      | Deforestation                    | Forest area                                                                 |
| Water scarcity       | Water withdrawal                 | Water withdrawal per year                                                  |

2.2. Selected SDG-related indicators
We selected nine indicators (table 1) that were relevant to five SDGs, including combat hunger (SDG 2), reduce deaths from air pollution (SDG 3.9), affordable and sustainable water (SDG 6), affordable and clean energy (SDG 7), and sustainable forest management (SDG 15.2). The selection criteria for these indicators have been explained by Liu et al [13]. The electricity price and water withdrawal are indicators that are newly added in this study. They reflect the economic burden of energy consumption on the poor and the demand-side pressure on water-scarce conditions.

2.3. Scenarios
We consider two dimensions in scenario design, namely climate policy and socioeconomic conditions (figure 1). For the climate policy dimension, we create two scenarios, namely, the BaU scenario and the 2Deg scenario. The BaU scenario assumes that societal changes follow historical trends, and no climate policy is implemented; the global mean temperature increase is 3.2 °C–4.1 °C, and radiative forcing is 5.4–7.2 W m$^{-2}$ (supporting information, figures S2 and S3). The 2Deg scenario is consistent with the goal of a temperature rise of no more than 2 °C; the global mean temperature increase in 2100 is 1.6 °C–1.7 °C, and the radiative forcing is 2.5–2.9 W m$^{-2}$.
Table 2. Additional socioeconomic scenarios.

| Scenarios                      | Individual socioeconomic factors changing from SSP2 to SSP1 |
|-------------------------------|-------------------------------------------------------------|
| Land system management       | Yield improvement                                           |
| Lifestyle change              | Transportation demand                                       |
| GDP and population Governance| GDP                                                         |
| Energy system development     | Trade openness                                              |
| Air control policies          | Social acceptance of energy technologies                   |
|                              | Air quality control                                         |
| Diet change                   | Population                                                  |
|                              | Food distribution                                           |
| Preference for industrial goods| Energy efficiency improvement                               |
|                              | Technology improvement in energy supply sector              |

global carbon price is assumed to be a cost-effective tool for achieving a certain level of emission reduction each year in the 2Deg scenario. The greenhouse gas (GHG) emission pathways can be found in figure S1 of supporting Information. For the socioeconomic dimension, we create five SSPs scenarios. The future socioeconomic assumptions and parameter settings follow the Shared Socioeconomic Pathway framework [28].

In addition to these combinations of basic scenarios, we explore (section 3.3) another six socioeconomic scenarios in which we replace individual factors in the SSP2 scenario with the corresponding SSP1 assumption. Table 2 shows the factors that are changed in the different socioeconomic scenarios, supporting Information (table S1) provides details about the scenario assumptions.

3. Results

This section first demonstrates the impacts of different combinations of climate policy scenarios and SSPs scenarios on SDG-related indicators. The effects of climate policies and socioeconomic conditions on those indicators are then compared, and GHG emissions, economic growth, and other SDGs related to those indicators are assessed comprehensively. Finally, we identify the instrumental roles of the different socioeconomic factors based on their impacts on the SDG-related indicators.

3.1. Impacts on SDG-related indicators of the different combinations of climate policy scenarios and SSP scenarios

Table 3 summarizes the quantitative impacts of different SSPs scenarios on SDG-related indicators by comparing 2050–2005 in terms of BaU, comparing the 2Deg scenario to the BaU scenario in 2050, and comparing the SSP1 scenario to different SSPs scenarios for the 2Deg scenario in 2050. The absolute values of the metrics in the base year (2005) are also shown. The results are percentage change with reference to the base year value.

Clearly the energy diversity indicator improves through time under the BaU scenario. Climate policy greatly accelerates the improvement in 2050, mainly because of the development of low-carbon technologies in the energy system, whereas the effect of socioeconomic factors is subtle and unclear. Another indicator of energy security is the price of electricity. It represents the affordability of energy use, which is particularly relevant to persons with low incomes. Although the price of electricity under the BaU scenario slowly decreases, climate policy imposes a carbon tax on the price of electricity that greatly increases energy prices, especially under the SSP3 and SSP5 scenarios. This price increase is a new energy-related concern for low-income persons. However, in contrast with the SSP3 and SSP5 scenarios, an SSP1 scenario coupled with climate policies would not lead to as much concern about the cost of energy for low-income persons.

The decrease of forest area through time under the BaU scenario indicates that a risk of deforestation is associated with economic development worldwide. Climate policy has a positive impact on forest area because the carbon tax raises the value of forests. Thus, mitigation measures such as afforestation and the avoidance of deforestation should be expected to increase forest area. The impact of socioeconomic factors on the forest area is relatively marginal and unclear.

Food price gradually increases under the BaU scenario. However, the total population at risk of hunger decreases because of economic and social developments. Climate policy increases the price of food and the total population at risk of hunger. Concerns over food security could therefore impede the implementation of climate policies, especially for those policies directed at the agricultural sector. The difference between the SSP1 and other SSPs pathways is generally larger than the effects of climate policy, except for the SSP5 pathway. This is most apparent under the SSP3 scenario.

Air quality improves under the BaU scenario because of global technological developments and effective policies for control of air quality. The effects of both climate policies and socioeconomic factors are able to accelerate this improvement; these effects are most prominent for the SSP3 and SSP4 scenarios.

Water scarcity problems become more severe under the BaU scenario through time, primarily because of population growth and economic growth
Table 3. Comparisons of positive impacts (green) and negative impacts (red) on SDG-related indicators.

| Scenarios          | Base year absolute value in 2005 | BaU scenarios in 2050 compared with base year (% change) | Climate policy scenarios in 2050 compared to BaU (% change of base year value) | Improve from SSPx to SSP1 in 2050 for 2 degree scenarios (% change of base year value) |
|--------------------|----------------------------------|---------------------------------------------------------|-----------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| Electricity Price  | 25.19 US$2005/GJ                 | -9 -11 -9 -4 -21                                        | 39 36 79 24 72                                                             | 5 -39 11 -21                                                                      |
| Energy Diversity   | Index                            | -9 -6 -6 -13 -1                                        | -42 -41 -50 -32 -51                                                        | -4 5 -6 1                                                                          |
| Forest Area        | 3904 million ha                  | -3 -6 -9 -5 -6                                        | 23 23 29 18 31                                                             | 3 -1 7 -5                                                                          |
| Food Price         | Index (2005=1)                   | 8 10 15 11 11                                        | 5 8 19 4 16                                                                | -5 -21 -2 -14                                                                      |
| People in Hunger   | 836.9 million                    | -85 -66 -7 -30 -90                                    | 5 12 43 12 8                                                                | -26 -116 -62 3                                                                    |
| SO2 Emissions      | 19.3 Mt/yr                       | -75 -64 -6 -37 -60                                    | -10 -21 -58 -31 -25                                                        | 0 -21 -18 0                                                                       |
| NOx Emissions      | 123.3 Mt/yr                     | -44 -18 33 -11 -17                                    | -17 -31 -62 -29 -42                                                        | -13 -32 -21 -3                                                                    |
| BC Emissions       | 8.335 Mt/yr                     | -62 -43 7 -23 -55                                     | 0 -1 -23 -7 -3                                                             | -17 -47 -32 -4                                                                    |
| Water Withdrawal   | 3544 km3/yr                      | 59 78 91 76 82                                        | -4 -2 -16 -1 -5                                                             | -21 -21 -20 -23                                                                   |

Note: SSPx (where $x = 2, 3, 4, \text{ and } 5$) represents a particular SSP scenario other than SSP1.
Figure 2. Comparison between climate policy and socioeconomic effects on selective SDG-related indicators. In each disaggregated bar, the effect of climate policy is the difference between the SSPx_2Deg scenario and the SSPx_BaU scenario in 2050; the socioeconomic effect is the difference between the SSPx_BaU and base year. Socioeconomic effects are derived from comparisons within the same SSP. The results are shown as values for the year 2050 relative to the base year.

3.2. Comparison of the roles of mitigation policies and socioeconomic conditions in achieving SDGs

We further compare the effects of mitigation policies and socioeconomic conditions on each SDG indicator (See figure 2). Here differences between the 2Deg and BaU scenarios are seen as effects of mitigation policies, whereas differences between the BaU and base year across SSPs scenarios are quantified effects of socioeconomic conditions.

The results show that climate policies are the main determinants of energy security and forest area, whereas socioeconomic factors impose relatively large, positive effects on food security and water scarcity. Under the SSP3 scenario, climate policies lead to more co-benefits with respect to air quality than socioeconomic conditions, which do not improve air quality. But for other SSPs scenarios, the effect of socioeconomic conditions on air quality is much larger than that of climate policies.

Climate policies tend to have both co-benefits (e.g., improvement of energy diversity and forest area) and trade-offs (e.g., higher prices for electricity and more people at risk of hunger). However, with the exception of the increased risk of deforestation in the absence of an assumed additional policy support, socioeconomic conditions positively affect the indicators under almost all the scenarios. In particular, because socioeconomic conditions reduce the price of electricity and the number of people at risk of hunger, they alleviate the negative effects caused by climate policies.

3.3. Sustainable development pathways

Figure 3 illustrates percentage changes of risk levels for GHG emissions and economic growth, as well as other SDG-related indicators. This subsection compares the results of the integrated assessments among the climate policy scenario without the SSP1 socioeconomic green growth improvement (SSP2_2Deg), the SSP1 scenario without climate policy (SSP1_BaU), and the scenario with both climate policy and SSP1 green growth socioeconomic improvement (SSP1_2Deg). The results are percentage changes of risk levels relative to the to SSP2_BaU scenario.

The relative changes for the SSP1_BaU scenario are negative in every case except for food prices. The implication is that the results, including GHG emissions, are an improvement over the SSP2_BaU scenario.
scenario in all cases except for food prices. However, because this scenario did not include the implementation of climate policies, the climate change goal is not achieved (supporting Information figure S1).

The SSP2_2Deg scenario achieves the 2 °C target but without improving the socioeconomic conditions relative to the SSP1 scenario. Figure 3 shows that climate policies may lead to some trade-offs regarding food security and the cost of energy. It can also bring some benefits in terms of air quality, energy diversity, and afforestation.

The indicators for the SSP1_2Deg scenario, in contrast, are improved relative to the SSP2_2Deg scenario for almost all the SDGs, and there is much less of an adverse effect on GDP. The implication is that socioeconomic improvement, if coupled with climate policies, is a preferable scenario because it can help increase co-benefits and reduce trade-offs.

3.4. Identifying important socioeconomic factors
This subsection shows the scenarios in which different socioeconomic factors are changed from the SSP2 scenario to the SSP1 scenario. The SSP2_2Deg scenario is used as the benchmark scenario, and the important socioeconomic factors constrained by achieving the 2 °C goal are investigated.

The results show that socioeconomic assumptions influence SDG indicators in different ways (figure 4). Whereas most socioeconomic factors contribute to improvement of energy diversity, the price of electricity is primarily affected by the development of energy systems. Technological innovations decrease the cost of energy and alleviate the adverse effects of high energy costs on low-income families. Energy system development may negatively affect forest area, because it increases the share of bioenergy in the energy system. Food security is deeply affected by GDP and uncertainties about the size of the population at risk of hunger. But better land management and technological improvements in the energy sector can help to reduce food prices and therefore decrease the number of people at risk of hunger. Socioeconomic changes may also affect the prices of commodities, and the price of food, another indicator of food security, may therefore be negatively affected by the GDP, governance, and air control policies. Air pollution policy is the factor that reduces emissions of SO₂, NOₓ, and black carbon the most, although other factors also make large contributions. However, the results show that economic growth might inevitably cause sulfur emissions to increase. All of the socioeconomic factors considered in this study improve the availability of water, and lifestyle changes make the greatest contribution.

The results reveal the impact of different socioeconomic factors on different SDG indicators and help to identify the factors that most impact those indicators. These results provide valuable insights about a diversity of sustainable issues for societal groups.

4. Discussion
In this study we apply SSPs from the BaU and 2Deg climate policy scenarios to explore the impact of socioeconomic conditions on the achievement of SDGs. We use SSPs scenarios to represent different socioeconomic conditions. The differences between SSP1 and SSP2 or other SSPs could be interpreted as uncertainties in the societal revolution, the efforts
Figure 4. Sensitivity analysis of different SDG-related indicators to changes of socioeconomic factors in scenarios from SSP2 to SSP1. The results are changes relative to the indicators in the SSP2 scenario.

made to transform society, or different policy choices and pathways. For example, although uncertainty exists in future population projections, we could slow the population growth rate by enhancing the education level of women, particularly in less developed regions.

Results show that a sustainable socioeconomic pathway could not only improve conditions such as water availability under the BaU scenario but also offset the negative effects caused by mitigation policies such as the impacts of higher energy costs on low-income families and food security issues. Without climate policies, the SSP1 scenario would benefit almost all the SDGs. Under the 2 °C mitigation constraint, the SSP1 increases co-benefits and reduces the adverse effects of climate policy trade-off on SDGs. The implication is that, with or without climate policies, the SSP1 scenario is always preferable and is therefore worth pursuing. These results provide a further rationale for policy makers to pursue socioeconomic changes.

Under the climate policy scenarios where we use the ‘back-casting’ method to adopt the 2 °C climate goal as an external constraint on GHG emissions, we compare the performance of the SDGs under different socioeconomic scenarios. We find it informative to consider the socioeconomic policies as alternatives to climate mitigation measures, because, unlike climate policy effects, socioeconomic conditions can lead to positive impacts on almost all the SDGs. However, the SSP1 pathway itself cannot achieve climate goals. Climate policy makers may thus want to integrate efforts to implement climate policies with initiatives to promulgate societal changes, and they may want to rethink the best strategy for simultaneously achieving climate goals and social goals. In this way, climate goals, economic growth, and sustainability issues can be better managed together and with fewer political impediments.

The effect of socioeconomic conditions can be further interpreted as a resolution of sustainability issues along with climate change issues. In our previous work [8], we identified the effects of changes in socioeconomic conditions on the SSP1 climate change mitigation scenario in terms of the reduction of mitigation costs. Based upon that paper, we investigate the role of socioeconomic conditions on other aspects of SDGs. Climate policies would be easier to implement if they were coupled with reductions of mitigation costs and had fewer negative societal consequences, such as food insecurity and increased energy costs for low-income families. Our findings can better inform climate policy makers because the costs and trade-offs of SDGs can be considered and resolved by implementing complementary socioeconomic policies.
The neoclassic core of the CGE model determines the characteristics of the net negative effects of climate policy [29]. The model does not endogenize technological development, nor does it consider investment-driven economic growth. On the other hand, the impact of climate change is not calculated in the assessment. However, despite these limitations, this study does broaden the discussions of assessment of climate policy beyond the traditional economic indicators (GDP, welfare, and sometimes employment) by incorporating SDG-related aspects as co-benefits and trade-offs.

A globally uniform carbon price is assumed for the climate policy in this study because it is a cost-effective tool. However, the difficulty of implementing such a policy in the real world is well documented in the literature. This difficulty in turn supports the argument that the socioeconomic improvement, if coupled with climate policy, would be a preferable alternative. The SSP1 scenario calls for societal actions, namely, that all stakeholders, including local governments, businesses, and civil society, work together [30]. For example, recent studies have conceptualized the system of Avoid-Shift-Improve measures [31]. Circular economy is seen as a promising strategy for improving material efficiency, related energy use, GHG emissions, and environmental performance [32]. The cost of the societal transition is not taken into account in our model, and the actual implementation of the transition is not easy. Governments can enable such implementation through various policies, such as increasing investment in research and development, setting regulations concerned with energy efficiency, and by appropriate land use and city planning. In the meantime, rebound effects should be avoided by a carefully designed system for pricing resources. Lastly, coordination between various policies should be considered [4, 19, 33]. Climate policies, in particular, can aid policies targeting sustainable development. For example, the carbon tax revenue can be one potential source of the funds required for tackling sustainability issues such as food security [34]. Also, the agenda of climate actions can be coordinated with other local, national, or international policy regimes, such as biodiversity [35] or trade.

Some related issues in this research have not been explored because of limitations of our modelling framework. However, these issues deserve future exploration. First, there is a need for modelling of the impacts of socioeconomic policies. The scope of such modelling is large, and the modeling can usually be accomplished by combining integrated assessment models with other types of models. For example, improvement of material efficiency can be modelled by coupling industrial ecology methods and integrated assessment models. Energy demand reduction can be partly simulated with human behavior models, such as agent-based models. Second, we do not take into account all the interactions between SDGs. This issue is related to the first point, i.e. that future research work may be able to elaborate on modelling the linkages between some key determinants of societal issues. One application can be a discussion of the water-energy-food nexus, which suggests that issues of water scarcity, food security, and energy system sustainability are entwined. Third, the SDGs can be endogenized to further quantify the roles of socioeconomic factors and mitigation policies for the achievement of tangible goals. Goals can be set based on planetary boundary limits or policy targets at the global scale [36, 37] or country scale [38, 39]. More specific socioeconomic policies can then be implemented with a combination of climate policies.

5. Conclusions

Our study explores the importance of socioeconomic conditions in achieving climate goals and SDGs. We applied SSPs scenarios to the BaU and 2Deg degree climate policy scenarios using a global-scale model (AIM/CGE). Under those scenarios, we analyze the results of selective SDG indicators. We find that improvement of socioeconomic conditions from SSPx towards SSP1 can always improve the SDG indicators, with or without climate policies. In many respects, socioeconomic conditions are more important than climate policies in achieving SDGs, particularly in the cases of the SDGs concerned with food security and energy affordability; socioeconomic conditions are also more important with respect to simultaneous achievement of multiple SDGs. The advantages of a joint effort aimed at implementation of climate policies and promulgation of socioeconomic changes should be recognized by policy makers.

Data availability statement

The data that support the findings of this study are available upon reasonable request from the authors.

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