Declaración, basada en pruebas científicas, de las Sociedades Mundiales de Ciencias Acuáticas sobre la necesidad de emprender acciones urgentes contra el cambio climático causado por la humanidad

Running title: Las ciencias acuáticas muestran la necesidad de acción climática inmediata

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El agua es el recurso natural más importante de la Tierra ya que es vital para la vida. Los ecosistemas acuáticos, ya sean de aguas continentales o marinas, brindan múltiples beneficios a la sociedad humana, como por ejemplo el suministro de oxígeno, alimentos, agua potable y recursos genéticos; la regulación de la composición atmosférica y el clima; la purificación del agua; la amortiguación de las tormentas; la mitigación de inundaciones y sequías; su uso recreacional, y otros muchos servicios. Nuestra existencia y bienestar dependen de la salud y el buen funcionamiento de los ecosistemas acuáticos. Las personas nos distribuimos de manera natural alrededor del agua: aproximadamente el 40% de la población mundial vive a menos de 100 km (62 millas) de la costa[1].

Los recursos acuáticos de todo el mundo se encuentran ahora bajo la mayor amenaza en la historia de la humanidad. El cambio climático causado por el hombre está acelerando la degradación de los ecosistemas acuáticos y los servicios que brindan. Los ecosistemas acuáticos se encuentran entre los más afectados en todo el mundo (por ejemplo, en el caso de los ecosistemas acuáticos continentales, una medida de la biodiversidad, el índice planetario de vida para las poblaciones de especies, disminuyó un 83% de 1970 a 2014, mientras que, como ejemplo para los marinos, se prevé que hasta el 90% de los arrecifes de coral desaparecerán a mediados de siglo si continúan las tendencias actuales)[2].

Nosotros, los investigadores en ciencias acuáticas del mundo, nos pasamos la vida estudiando estos sistemas. Vemos cambios excepcionales e inquietantes en los ecosistemas acuáticos del mundo debido al cambio climático y creemos que debemos continuar compartiendo los hallazgos científicos revisados por pares con el público y los responsables políticos para enfatizar la gravedad de esta amenaza y la necesidad de acción inmediata. Por primera vez, la evaluación de riesgos globales realizada por el Foro Económico Mundial clasificó los impactos del "fracaso de la acción climática", la "pérdida de biodiversidad" y la "crisis del agua" entre los cinco riesgos principales durante la próxima década[3]. En los últimos años, las migraciones han aumentado y las tensiones geopolíticas se han exacerbado: entre 2008 y 2016, más de 20 millones de personas al año se han visto obligadas a desplazarse debido a fenómenos meteorológicos extremos, mientras que, según Naciones Unidas, en 2017 el agua era uno de los principales factores de conflicto en 45 países[3]. Se espera que estos efectos negativos aumenten con las tendencias climáticas actuales. Por ejemplo, en los Estados Unidos, se estima que el daño económico relacionado con el clima alcanzará el 10% del producto interior bruto a finales de siglo[3]. En Europa, el coste mínimo de no adaptarse al cambio climático se estima en 100 mil millones € por año en 2020 y en 250 mil millones de euros en 2050[4].

Expertos en los campos medioambiental, social y económico apuntan colectivamente hacia una grave crisis medioambiental y humanitaria, con repercusiones a nivel global, a menos que se implementen urgentemente acciones climáticas concertadas a nivel mundial.

Este documento resume los hallazgos científicos clave que destacan los efectos del cambio climático en los ecosistemas acuáticos. Estos estudios proporcionan evidencia de qué efectos están ocurriendo actualmente y por qué los líderes mundiales y la humanidad en su totalidad deben actuar de manera conjunta lanzando acciones coordinadas ahora si desean mitigar estos impactos.

El reto

- Miles de estudios revisados por pares realizados por científicos de instituciones autorizadas en todo el mundo han documentado evidencia de efectos climáticos en los sistemas acuáticos, así como que dichos efectos ya están ocurriendo y son generalizados[5].

- Numerosas fuentes respetadas a nivel mundial, incluida la American Geophysical Union[6], Academias Nacionales de Ciencias de docenas de países[7], el Panel Intergubernamental sobre Cambio Climático[8] o la Cuarta Evaluación Nacional del Clima de los EE.UU., apoyan las conclusiones de múltiples estudios de que el aumento de las concentraciones atmosféricas de gases de efecto invernadero –debidas a las emisiones antropogénicas- y los cambios en los usos del suelo, como la deforestación, están impulsando el cambio climático actual.
- Muchos de estos cambios son y serán irreversibles. Continuarán empeorando si persistimos en nuestra trayectoria actual[10].
- Los impactos que ya están ocurriendo incluyen una mayor frecuencia, intensificación y severidad de sequías, olas de calor, inundaciones, incendios forestales y tormentas; el deshielo de los glaciares y la desestabilización de las principales capas de hielo planetarias; cambios en las corrientes oceánicas y aumento del nivel del mar; la acidificación y desoxigenación de los océanos; cambios en la distribución de especies, incluida la expansión de especies exóticas invasoras; brotes de enfermedades de plantas acuáticas y vida silvestre; eventos masivos de blanqueamiento de corales entre otros muchos, con un costo creciente en ecosistemas vulnerables, sociedades humanas y economías locales y globales[11].
- Estos eventos son precursores de daños aún mayores a la pesca, la biodiversidad y la sociedad humana en su conjunto[12].
- Retrasar la acción para detener las causas subyacentes del cambio climático aumentará el impacto económico, medioambiental y sus consecuencias sociales[13].
- Si la humanidad desea evitar consecuencias catastróficas para nuestros ecosistemas acuáticos y los seres humanos que dependen de ellos, ahora es el momento de frenar las emisiones de gases de efecto invernadero, aumentar el secuestro de esos gases, y adaptarse a un clima ya cambiante[14]. Un movimiento rápido e inteligente hacia tales objetivos proporcionará grandes beneficios para los ecosistemas acuáticos y los seres humanos que dependen de ellos.
- Es posible una respuesta global rápida y acciones a gran escala si el público y los gobiernos se comprometen[15].

La evidencia: efectos sobre los recursos marinos

- Actualmente se están produciendo cambios en la composición, el comportamiento, la abundancia y la producción de biomasa de las especies[16].
- Las poblaciones de langostas[17], bacalao[18], caballa[19], peces de arrecifes de coral[20], y otras especies importantes para la pesca[21] están desplazándose hacia los latitudes más altas y aguas más profundas, o están en declive[22].
- Los ecosistemas costeros se están transformando, degradando o perdiendo, ya sea en gran parte[23] o en parte, debido al cambio climático, incluyendo las praderas marinas[24], los manglares[25], los arrecifes de coral [26] y los bosques de kelp (algas gigantes)[27].
- Los efectos de la alteración de la composición de especies están afectando a ecosistemas enteros[28].
- Las emisiones de carbono provocan la acidificación global de los océanos, que está afectando la supervivencia de los organismos, especialmente los crustáceos, y la aceleración de la erosión de los arrecifes de coral[29].

- Se ha documentado el aumento de la frecuencia e intensidad de las olas de calor marinas y se prevé que continúe[30].
- Se han producido reducciones en las concentraciones globales de oxígeno disuelto en los océanos durante las últimas cinco décadas[31].
- El cambio climático está interactuando con otros factores estresantes, como el aporte excesivo de nutrientes[32], la sobreexplotación[33] e interacciones con nuevas especies[34] para perjudicar aún más a los ecosistemas marinos.
- El cambio climático está relacionado con brotes de enfermedades emergentes y reemergentes en la fauna marina y diversidad de especies de plantas[35].
- La producción mundial de animales marinos continúa disminuyendo y los cambios en la composición de especies seguirá aumentando a menos que se reduzcan las emisiones de gases de efecto invernadero[36].
- Las aves marinas son reconocidas como indicadoras de cambios medioambientales a largo plazo: casi tres de cada cuatro de las aves marinas del mundo han desaparecido desde 1950, y más de la mitad de las especies restantes enfrentan amenazas sustanciales[37]. Solo en América del Norte, dos tercios (389/604) de las especies de aves, que incluyen aves acuáticas, son moderada o altamente vulnerables al cambio climático en un escenario de incremento de temperatura de 3°C[38].

La evidencia: efectos sobre los recursos de aguas continentales

- Los ecosistemas acuaticos continentales se encuentran entre los más amenazados de la Tierra[39].
- Los ecosistemas acuaticos continentales cubren menos del 1% de la superficie del planeta, pero albergan un tercio de las especies de vertebrados y el 10% de todas las especies[40].
- La capacidad de adaptación de los ecosistemas acuaticos continentales es relativamente baja dada su naturaleza y la escala de los impactos del cambio climático[41].
- El cambio climático está alterando la abundancia, la dinámica depredador-presa, la expansión de especies invasoras, el crecimiento, el reclutamiento de especies y las interacciones con nuevas especies, lo que lleva a una disminución en el número y diversidad de organismos acuáticos de las aguas continentales[42].
- La mayor frecuencia, intensidad y duración de las sequías estáa afectando la cantidad y calidad de agua disponible tanto para los ecosistemas acuáticos continentales como para los seres humanos[43].
- El impacto del cambio climático en los regímenes de caudal, incluido tanto el aumento de las sequías y de los períodos de bajo caudal como el aumento de las inundaciones, impactan a las especies nativas con rangos estrictos de requisitos de caudal y permiten la expansión de especies exóticas invasoras que afectan la pesca recreativa y comercial de peces y obstruyen las vías navegables[44].
- Los rangos geográficos de muchas plantas y animales se han movido hacia altitudes más altas, mientras que las especies exóticas invasoras se expanden con las condiciones cada vez más cálidas[45]. A diferencia de los sistemas marinos, en los ecosistemas de acuaticos continentales los caminos hacia otros hábitats a menudo están bloqueados, lo que lleva a extinciones locales de especies[46].

- Los cambios temporales en las señales estacionales, como la escorrentía de primavera o las temporadas de monzones, afectan el éxito de desove de los peces, lo que resulta en una escasa supervivencia[47].
- La mayor incidencia de incendios forestales está afectando los sistemas acuáticos al hacer que las cuencas hidrográficas sean más susceptibles a las inundaciones y al reducir la calidad del agua, especialmente con la deposición de sedimentos y cenizas posteriores al incendio[48].
- La capacidad de los humedales para el almacenamiento de carbono y la mitigación del cambio climático está viéndose reducida por cambios relacionados con el cambio climático y otros componentes del cambio global, como el aumento del desarrollo urbanístico y los incendios[49].
- El aumento de las temperaturas y la escorrentía de las precipitaciones han favorecido las proliferaciones de algas nocivas, que pueden dañar a peces, mamíferos, aves e incluso a los humanos[50].
- El cambio climático puede actuar en sinergia con los nutrientes para magnificar la eutrofización y degradar aún más la calidad del agua y los servicios de los ecosistemas, lo que además afecta al agua potable[51].
- Los organismos que dependen del deshielo de la nieve y las corrientes glaciares están disminuyendo o cambiando su distribución[52].
- Se prevé que la liberación de metales pesados como el mercurio, actualmente almacenado en los glaciares y el permafrost, afectará aún más a los organismos de las aguas continentales[53].
- El cambio climático está relacionado con brotes de enfermedades emergentes y reemergentes en especies de plantas y vida silvestre de las aguas continentales [54].
- Estos cambios aparentemente diversos y de pequeña escala se combinan de manera acumulativa para crear múltiples y cada vez más estresantes desafíos para las especies acuáticas[55].

La evidencia: bienes en la sociedad mundial que dependen de los recursos acuáticos.

- Todas las formas de vida necesitan agua limpia y suficiente.
- Las pesquerías proporcionan fuentes de proteínas de calidad que no son fácilmente reemplazables por fuentes terrestres. De acuerdo con la Organización de las Naciones Unidas para la Agricultura y la Alimentación, el pescado representa el 17% de la proteína animal consumida a nivel mundial, la pesca y la acuicultura emplean directamente a casi 60 millones de personas, ymientras que el comercio mundial de productos pesqueros ha alcanzado los 152.000 millones de dólares al año, de los cuales el 54% se origina en países en desarrollo[56].
- A corto plazo, están apareciendo nuevas pesquerías en algunas áreas sin hielo recién formadas[57]; sin embargo, se prevé que la captura pesquera general disminuirá debido a la disminución creciente de la calidad del agua y la producción primaria como resultado del cambio climático, con los correspondientes efectos en la seguridad alimentaria[58]. El calentamiento de los océanos y los cambios en la productividad primaria están relacionados con cambios en muchas poblaciones de peces. El restablecimiento de la población de peces ha disminuido un 3% por década, y el potencial máximo de captura disminuyó un 4,1% durante el siglo XX[59]. Se prevé que los aumentos de la temperatura del agua debido al cambio climático superarán los límites

de tolerancia de entre el 10% y el 60% de las especies de agua continentales y marinas para 2100, dependiendo de la cantidad de emisiones de gases de efecto invernadero[60].

- Los impactos del cambio climático en los ecosistemas acuáticos están afectando de manera directa a los ingresos, la seguridad alimentaria, la cultura y los medios de vida de las comunidades que dependen de éstos recursos[61].
- Los cambios en las especies están afectando a las pesquerías tradicionales desde los trópicos hasta las regiones polares a través de la reducción del acceso a las poblaciones de peces, las zonas de pesca y la pérdida de conocimientos locales[62].
- El cambio climático agrava el impacto de otras prácticas como la contaminación, la sobrepesca y el desarrollo costero insostenible. Se prevé que estos impactos combinados acabarán con la existencia de muchas pesquerías y economías locales[63].
- El calentamiento de las masas de agua afecta la seguridad sanitaria de los mariscos consumidos por los humanos a través de una elevada bioacumulación de metales pesados y contaminantes y una mayor prevalencia de patógenos transmitidos por el agua que afectan la salud humana y animal[64].
- El turismo y los sitios turísticos se ven afectados en muchas áreas que dependen de los ecosistemas locales.
- El buceo, el esnórquel, la pesca con caña, la observación de aves y mamíferos marinos y otras actividades recreativas y negocios sostenibles dependen del mantenimiento de recursos acuáticos saludables[65].
- El cambio climático degrada los ecosistemas costeros como manglares, praderas marinas, marismas, turberas y arrecifes de coral, que brindan servicios a los humanos tales como proteger las costas de la erosión, tormentas e inundaciones, proporcionando un hábitat clave para la vida silvestre y secuestrando carbono[66].
- El cambio climático daña los ecosistemas fluviales y ribereños, que brindan servicios a los humanos como protección de las inundaciones, además de interceptar contaminantes, reducir la erosión, proporcionar sombra y hábitat para la vida silvestre, secuestrar carbono y almacenar agua durante eventos de elevado caudal[67].
- El cambio climático contribuye a dañar los lagos y humedales, que brindan muchos de los servicios como los indicados anteriormente. Los humedales juegan un papel fundamental en el almacenamiento y secuestro de carbono. En particular, las turberas, a pesar de ocupar el 3% de la superficie terrestre, almacenan el doble de carbono que los bosques del mundo[68].
- La severidad de los impactos se regirá por el nivel de restricción que impongan nuestras naciones a las emisiones futuras combinado con la zonificación ribereña y costera y los cambios en las prácticas de gestión pesquera[69].

Las respuestas necesarias

- Afirmamos que es necesaria una acción rápida para frenar drásticamente la liberación de gases de efecto invernadero y para eliminar CO_2 de la atmósfera y almacenarlo en ecosistemas naturales, para asi evitar las consecuencias más catastróficas del cambio climático causado por el hombre en los ecosistemas acuáticos, tanto marinos como continentales, de los que depende toda la humanidad.

- Son necesarios objetivos mundiales y nacionales para proteger y restaurar ecosistemas sumideros de carbono, como las turberas, las praderas marinas y otros humedales que contribuyen a secuestrar carbono, y con ello prevenir emisiones de gases de efecto invernadero y reducir los impactos del cambio climático.
- Los gobiernos, las personas, la industria, la academia y todos los demás sectores de la sociedad deben priorizar las acciones y actuar de manera coordinada para detener el cambio climático causado por el hombre si quieren evitar consecuencias nefastas.
- Se requiere una transición rápida hacia fuentes de energía y otros productos y servicios que no liberen gases de efecto invernadero, así como investigaciones y políticas que favorezcan una transición eficiente hacia una economia descarbonizada para frenar la degradación de los sistemas acuáticos. Todos los gobiernos podrían lograr dicha transición si actuaran inmediatamente con el asesoramiento de especialistas en tecnologías de energía verde, secuestro de carbono, marketing, educación, principios socioeconómicos y disciplinas relacionadas.
- Medidas de adaptación sólidas, la identificación y reducción de otros factores ambientales estresantes que actúan de manera sinérgica con el cambio climático; la asignación de recursos adicionales para la recopilación de datos, el mapeo y la investigación para comprender mejor los impactos potenciales y proporcionar a las agencias gestoras de recursos naturales con las herramientas para mitigar estos impactos, son esenciales para comprender mejor y planificar los cambios en los ecosistemas acuáticos.
- Si se hace de manera inteligente, el movimiento para reducir el cambio climático causado por la especie humana puede resultar en tecnologías avanzadas y novedosas; economías fuertes; ecosistemas acuáticos más saludables; mayor seguridad alimentaria y un incremento del bienestar humano.

Es hora de reconocer la urgente necesidad de actuar para afrontar el cambio climático. Retrasar las acciones necesarias para controlar las emisiones de gases de efecto invernadero no es una opción si la humanidad desea conservar los recursos acuáticos y la seguridad ambiental del planeta.

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Pörtner, H.-O., D. C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, and N. M. Weyer, editors. 2019. IPCC special report on the ocean and cryosphere in a changing climate. Available: www.ipcc.ch/srocc/home/. (July 2020).

These are just the beginning of peer-reviewed studies and peer-reviewed compilations of studies that discuss human-caused climate change and the effects of climate change on aquatic ecosystems. Other reports that include both projections and already observed effects on aquatic systems are as follows:

Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel, and J. C. Minx, editors. 2014. Climate change 2014: mitigation of climate change. Contribution of Working Group III to the fifth assessment report of the Intergovernmental Panel on Climate Change. Cambridge University Press, New York. [This report gives methods to control greenhouse gas emissions and other ways to "mitigate" or control the factors affecting climate change itself. Cites close to 10,000 studies.]

Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P. R. Shukla, A. Pirani, W. Moufou-ma-Okia, C. Péan, R. Pidcock, S. Connors, J. B. R. Matthews, Y. Chen, X. Zhou, M. I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield, editors. 2018. Global warming of 1.5°C. An IPCC special report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. Available: www.ipcc.ch/site/assets/uploads/sites/2/2019/06/SR15_Full_Report_High_Res.pdf. (September 2020). [Cites effects on a variety of systems, including both aquatic and terrestrial. The press release accompanying this document states report cites more than 6,000 scientific references and resulted from contribution of thousands of expert and government reviewers worldwide.]

Paukert, G. P., A. J. Lynch, and J. E. Whitney, editors. 2016. Effects of climate change on North American inland fishes. Fisheries 41(7). [Full issue concerning effects of climate change on inland fishes containing more than 90 authors and more than 600 cited references.]

Reidmiller, D. R., C. W. Avery, D. R. Easterling, K. E. Kunkel, K. L. M. Lewis, T. K. Maycock, and B. C. Stewart, editors. 2018. Impacts, risks, and adaptation in the United States: fourth national climate assessment,

volume II. U.S. Global Change Research Program, Washington, D.C. [Cites effects on a variety of systems, including both aquatic and terrestrial. More than 5,600 references cited, mostly peer-reviewed, and data sets.]

Stocker, T. F., D. Qin, G.-K Plattner, M. Tignor, S. K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex, and P. M. Midgley, editors. 2013. Climate change 2013: the physical science basis. Contribution of Working Group I to the fifth assessment report of the Intergovernmental Panel on Climate Change. Cambridge University Press, New York. [Discusses the physical scientific evidence for change to both terrestrial and aquatic systems, citing more than 9,200 scientific publications according to the Working Group 1 fact sheet.]

Wuebbles, D. J., D. W. Fahey, K. A. Hibbard, D. J. Dokken, B. C. Stewart, and T. K. Maycock, editors. 2017. Climate science special report: fourth national climate assessment, volume I. U.S. Global Change Research Program, Washington, D.C. [Cites effects on a variety of systems, including both aquatic and terrestrial. Number of references not provided, but likely similar to U.S. Global Change Research Program 2018.]

6. American Geophysical Union (AGU). 2019. Society must address the growing climate crisis now. Position statement. AGU, Washington, D.C.
7. Statements from various academies of sciences include the following:

European Academy of Sciences. 2015. Statement. Facing critical decisions on climate change in 2015. Available: https://easac.eu/publications/details/facing-critical-decisions-on-climate-change-in-2015/. (September 2020).

The Royal Society and the U.S. National Academy of Sciences. 2020. Climate change evidence & causes: update 2020. An overview from the Royal Society and the US National Academy of Sciences. Avail-able: https://royalsociety.org/-/media/Royal_Society_Content/policy/projects/climate-evidence-causes/ climate-change-evidence-causes.pdf. (September 2020).

Academies of Science for the G8+5 Countries. 2008. Joint science academies' statement: climate change: adaptation and the transition to a low carbon society. Available: http://insaindia.res.in/pdf/Climate_05.08_W.pdf. (September 2020).

Academies of Science for the G8+5 Countries. 2007. Joint science academies' statement on growth and responsibility: sustainability, energy efficiency and climate protection. Available: www.scj.go.jp/ja/info/kohyo/pdf/kohyo-20-s4.pdf (September 2020).

Network of African Science Academies (NASAC). 2007. Joint statement by the Network of African Science Academies (NASAC) to the G8 on sustainability, energy efficiency and climate change. Available: www.interacademies.org/sites/default/files/publication/nasac_g8_statement_07_-_low_res.pdf. (September 2020).

Interacademy Medical Panel (IAMP). 2010. Statement on the health co-benefits of policies to tackle climate change. Available: www.interacademies.org/statement/iamp-statement-health-co-benefits-policies-tackle-climate-change. (September 2020).

8. See references in 5. References that cite the causes of climate change, including thorough discussions that show overwhelming evidence that emissions are the chief factor, are found in Collins et al. (2013), Edenhofer et al. (2014), and Masson-Delmotte et al. (2018).
9. See references in 5. Wuebbles et al. (2017) is the primary U.S. report that discusses the physical basis of climate change.
10. "As a result of the large ocean inertia and the long lifetime of many greenhouse gases, primarily carbon dioxide, much of the warming would persist for centuries after greenhouse gas emissions have stopped." [From Collins, M., R. Knutti, J. Arblaster, J.-L. Dufresne, T. Fichefet, P. Friedlingstein, X. Gao, W. J. Gutowski, T. Johns, G. Krinner, M. Shongwe, C. Tebaldi, A. J. Weaver, and M. Wehner. 2013. Long-term climate change: projections, commitments and irreversibility. Pages 1029–1136 *in* T. F. Stocker, D. Qin, G.-K. Plattner, M. Tignor, S. K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex, and P. M. Midgley, editors. Climate change 2013: the physical science basis. Contribution of Working Group I to the fifth assessment report of the Intergovernmental Panel on Climate Change. Cambridge University Press, New York.]

See also the following:

Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P. R. Shukla, A. Pirani, W. Moufou-ma-Okia, C. Péan, R. Pidcock, S. Connors, J. B. R. Matthews, Y. Chen, X. Zhou, M. I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield, editors. 2018. Summary for policymakers. Pages 1–24 in Global warming of 1.5°C. An IPCC special report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. Available: www.ipcc.ch/site/assets/uploads/sites/2/2019/05/SR15_SPM_version_ report_HR.pdf. (September 2020).

Pörtner, H.-O., D. C. Roberts, V. Masson-Delmotte, P. Zhai, E. Poloczanska, K. Mintenbeck, M. Tignor, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, and N. M. Weyer, editors. 2019. Technical summary.

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12. For increasing impacts on the world's oceans, freshwaters, and societies, start with the following:

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Hoegh-Guldberg, O., D. Jacob, M. Taylor, M. Bindi, S. Brown, I. Camilloni, A. Diedhiou, R. Djalante, K. L. Ebi, F. Engelbrecht, J. Guiot, Y. Hijioka, S. Mehrotra, A. Payne, S.I. Seneviratne, A. Thomas, R. Warren, and G. Zhou. 2018. Impacts of 1.5°C global warming on natural and human systems. Pages 175–311 in V. Masson-Delmotte, P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P. R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J. B. R. Matthews, Y. Chen, X. Zhou, M. I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield, editors. Global warming of 1.5°C: an IPCC special report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. Available: www.ipcc.ch/site/assets/uploads/sites/2/2019/02/SR15_Chapter3_Low_Res.pdf. (July 2020).

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