Climate Change, Scale, and Devaluation: The Challenge of Our Built Environment

Nathan F. Sayre[*]

Abstract

Climate debate and policy proposals in the United States have yet to grasp the gravity and magnitude of the challenges posed by global warming. This paper develops three arguments to redress this situation. First, the spatial and temporal scale of the processes linking greenhouse gas (GHG) emissions to climate change is unprecedented in human experience, challenging our abilities to comprehend, let alone act. An adequate understanding of the scale of global warming leads to an unequivocal starting point for all discussions: we must leave as much fossil fuel in the ground as possible, for as long as possible. Second, a policy informed by this insight must focus on the built environment, which mediates economic production, exchange, and consumption in ways that both presuppose and reinforce high rates of GHG emissions, especially in the U.S. A rapid and comprehensive reconfiguration of the built environment is imperative if we are to mitigate and adapt to global warming. Third, the obstacles and opposition to such a reconfiguration are best understood in terms of the devaluation of fixed capital, public and private investments alike, that has been sunk in the built environment of the present. In a fortuitous paradox, these investments are threatened with devaluation whether or not we act to stabilize the atmospheric GHG concentrations; in highly uneven, unpredictable, and potentially abrupt ways, global warming will make our current built environment increasingly untenable and uneconomical. There is, therefore, no reason not to be proactive and to craft policies with the goal of completely redesigning and rebuilding our built environment over the next 20 to 50 years.

Keywords: climate change, global warming, scale, fixed capital, devaluation, built environment

[*] Department of Geography, University of California-Berkeley, 507 McCone Hall, #4740, Berkeley, CA 94720-4740, nsayre@berkeley.edu.

Table of Contents

I. Introduction

Writing in *Science Magazine*[1] in 2007, renowned climate scientist Wallace Broecker declared, "[i]f we are ever to succeed in capping the buildup of the atmosphere's CO_2 content, we must make a first-order change in the way we view the problem."[2] He pointed out that merely reducing the rate of greenhouse gas (GHG) emissions is insufficient, as this would still result in a continuing rise in atmospheric GHG concentrations, and therefore continued global warming.[3] The only real solution, Broecker argued, is to stabilize concentrations, and he offered the following "CO_2 Arithmetic" to clarify the implications:

> Currently, for each 4 gigatons (Gt) of fossil carbon burned, the atmosphere's CO_2 content rises about 1 ppm; including deforestation, we now emit about 8 Gt of carbon per year. Further, this four-to-one ratio will only change slowly in the coming decades. Hence, if we set a desirable upper limit on the extent to which we allow the CO_2 content of the atmosphere to increase, then this fixes the size of the carbon pie.[4]

The point of the pie metaphor is that GHG emissions must be limited *absolutely* to achieve any real solution to climate change. For example, to achieve stabilization at twice pre-industrial levels, which is considered by many scientists to be dangerously high but is still much lower than the projection for 2100, humanity can only emit about 720 Gt of additional carbon *from now onwards*.[5] We will exhaust the carbon pie before the end of the century at current rates of GHG emissions, and much sooner if rates increase as expected. Broecker, believing that such a target is unattainable by other means, went on to argue for technologies to capture CO_2 directly

---

1 Wallace S. Broecker, *Climate Change: CO_2 Arithmetic*, SCI. MAG., Mar. 9, 2007, at 1371.

2 *Id.*

3 *See id*.

4 *Id*.

5 The carbon pie has already shrunk since Broecker wrote. It now amounts to about 696 Gt, as concentrations have risen from 380 to 386 ppm.

from the atmosphere,[6] a strategy he describes at greater length in the book *Fixing Climate*.[7] Such technologies, if they can be invented and deployed on an enormous scale, would expand the carbon pie and relax the limits that Broecker described. Counting on such a silver bullet is a high-risk strategy, however, akin to continuing to smoke on the assumption that a cure to cancer will be found in time to save you. Technological optimism may also distract us from making the "first-order change in the way we view the problem" that Broecker urged in the opening sentence of his article.[8] Understanding the climate science behind Broecker's CO_2 arithmetic is only one part of making this change; we must also consider political and economic circumstances, which are absent from his analysis. Why does addressing climate change require an absolute limit on total GHG emissions, and not just reductions in emissions rates? How can we realize such a limit? Finally, why does it seem so unattainable? What are the fundamental obstacles to an adequate climate policy?

I offer three interlinked arguments in answer to these questions. First, the spatial and temporal scale of the processes linking GHG emissions to climate change is unprecedented in human experience, challenging our abilities to comprehend, let alone act. An adequate understanding of the scale of global warming leads to an unequivocal starting point for all discussions: *we must leave as much fossil fuel in the ground as possible, for as long as possible*. Second, policies informed by this insight must focus on the built environment, which mediates economic production, exchange, and consumption in ways that both presuppose and reinforce high rates of GHG emissions, especially in the U.S. A rapid and comprehensive reconfiguration of the built environment is imperative if we are to mitigate and adapt to global warming. Third, the obstacles and opposition to such a reconfiguration are best understood in terms of the devaluation of fixed capital, public and private investments alike, which has been sunk in the built environment of the present. In a fortuitous paradox, these investments are threatened with devaluation whether or not we act to stabilize atmospheric GHG concentrations; in highly uneven, unpredictable, and potentially abrupt ways, global warming will make our current built environment increasingly untenable and uneconomical. Therefore, there is no reason not to be proactive and to craft policies with the goal of completely redesigning and rebuilding our built environment over the next 20 to 50 years.

---

6 *See id*.

7 *See* WALLACE S. BROECKER & ROBERT KUNZIG, FIXING CLIMATE: WHAT PAST CLIMATE CHANGES REVEAL ABOUT THE CURRENT THREAT—AND HOW TO COUNTER IT. (Hill and Wang 2008).

8 Broecker, *supra* note 1, at 1371.

II. The Scale of Global Warming

Science journalist Elizabeth Kolbert has written that "[f]or better or (mostly) for worse, global warming is all about scale."[9] Scientists typically define scale in terms of *grain* or *resolution*, on the one hand, and *extent,* on the other.[10] Grain refers to the smallest unit of measurement employed to study some phenomenon, and therefore the precision or detail that can be detected.[11] Extent is the overall dimensions over which observations are made, including both space (area) and time (duration).[12] Different phenomena require different scales, because the grain and extent of a study need to "fit" what one is observing in order to detect meaningful patterns or dynamics. A simple illustration: the grain used to time a race has to be fine enough to distinguish among the racers. In world-class swimming, for example, this is hundredths or even thousandths of a second; if the grain were coarser—seconds, in this example—there would be lots of ties, defeating the purpose of the race. Generally speaking, grain and extent vary in rough proportion to each other: a large extent means a coarser grain, whereas a finer grain is called for when making measurements over smaller extents. Longer races, to continue the example, can generally be timed using larger units. This is the case for both methodological and ontological reasons.

If one applies this definition of scale to environmental phenomena themselves, rather than to the measurements used to study them, it becomes clear that Kolbert is right to suggest that the scale of global warming is unlike anything else that humanity has ever experienced.[13] The processes that link GHG emissions to climate change combine extremely fine grains and extremely large extents, both spatially and temporally.

Spatially, the grain is minutely small: individual molecules of CO_2 and other greenhouse gases.[14] They are invisible to the naked eye and produced in myriad ways, for example: when we breathe or turn over a spade of soil, when a plant decays, when a cow ruminates, as well as when wood, coal, gas or oil is burnt.[15] But the extent is global: all those molecules join the earth's atmosphere and quickly mix together, becoming

---

[9] ELIZABETH KOLBERT, FIELD NOTES FROM A CATASTROPHE: MAN, NATURE, AND CLIMATE CHANGE 3 (Bloomsbury Publishers 2006).

[10] *See* Nathan F. Sayre, *Ecological and Geographical Scale: Parallels and Potential for Integration*, 29 PROGRESS IN HUM. GEOGRAPHY 276, 278 (2005).

[11] *See id.* at

[12] *See id.* at

[13] KOLBERT, *supra* note 9, at

[14] See C.L. Sabine and R.A. Feely. 2003. *Carbon Dioxide*. Pp. 335-343 in J.R. Holton, J.A. Curry and J.A. Pyle, eds. ENCYCLOPEDIA OF ATMOSPHERIC SCIENCES. Academic Press. See also E.G. Nisbet. 2003. *Biogeochemical cycles: Carbon cycle*. Pp. 196-201 in J.R. Holton, J.A. Curry and J.A. Pyle, eds. ENCYCLOPEDIA OF ATMOSPHERIC SCIENCES. Academic Press. [USE THESE TWO SOURCES FOR FOOTNOTES 15, 16, 17, 19, 21, & 22.]

[15] See note 14 above.

equal parts of the enhanced greenhouse effect.[16] Over time, some CO_2 molecules are absorbed by plants, some by the oceans, some by the soil, and some eventually degrade or break down, but where or from what they were earlier emitted has no effect on the path they subsequently take.[17] The impacts of global warming are not homogeneous in space, and GHG emissions are also very unevenly distributed.[18] But *the process* by which greenhouse gases enhance the greenhouse effect is indifferent to such geographical specifics.

Temporally, the grain is likewise infinitesimal: that split second at which a chemical reaction occurs in combustion, photosynthesis, oxidation, decay, etc.[19] But the extent is very long: once a molecule of carbon dioxide or nitrous oxide enters the atmosphere, it remains there for more than a century; most other greenhouse gases persist for one-to-several decades.[20] Looking backward in time, the temporal extent is longer still, although it varies depending on the process by which a carbon molecule was earlier sequestered; it could be decades or centuries for carbon stored in trees, up to centuries for carbon in the soil, and hundreds of millions of years for the carbon in coal, gas or oil.[21] This combination of short grain and long extent means that whatever the amount of CO_2 emitted in excess of the amount reabsorbed or sequestered during a given period of time is out there for good, for all practical purposes.[22]

The difficulties of confronting global warming are a function of these unique scalar qualities. Such extreme disparities between spatio-temporal grain and extent are exceptional among environmental processes of any direct significance to humans. Pollution of air, water, and soil is often fine-grained, but usually local-to-regional in spatial extent, with a temporal extent of weeks to decades.[23] Even nitrogen loading and soil erosion, which have small grains, large extents, and persistent effects, can

---

16 See note 14 above. Other greenhouse gases have different global warming potentials (GWP) per molecule; I use CO_2 here because it is the single largest contributor to the enhanced greenhouse effect overall. The point is that greenhouse gases from all sources join the atmosphere at a global scale to produce warming.

17 See note 14 above.

18 Core Writing Team, R.K. Pachauri, and A. Reisinger (Eds.) Core Writing Team, Pachauri, R.K. and Reisinger, A. (Eds.). CONTRIBUTION OF WORKING GROUPS I, II AND III TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE. IPCC (2007).

19 See note 14 above.

20 *See* T.J. Blasing, *Recent Greenhouse Gas Concentrations*, CARBON DIOXIDE INFO. ANALYSIS CENTER, http://cdiac.ornl.gov/pns/current_ghg.html (last visited Oct. 15, 2009).

21 Blasing, *supra* note 20. See also note 14 above.

22 Sayre, *supra* note 9, at Blasing, *supra* note 20. See also note 14 above.

23 For air pollution see H.L. Windsor and R. Toumi. 2001. *Scaling and persistence of UK pollution.* ATMOSPHERIC ENVIRONMENT 35: 4545-4556. For soil and water pollution see K.C. Jones and P. de Voogt. 1999. *Persistent organic pollutants (POPs): state of the science.* ENVIRONMENTAL POLLUTION 100: 209-221.

be addressed at regional scales over periods of years to decades.[24] Earthquakes provide a partial analog to climate change, insofar as vast quantities of energy accumulate so slowly, over so much space and time, as to pass unnoticed until the event occurs.[25] Earthquakes, however, are temporally discrete and spatially limited, whereas climate change is global and, in most respects, extremely gradual in its effects. Radioactivity is analogous in a different way: it is invisibly small in substance yet persistent on a temporal scale of millennia and dispersed around the world due to above ground nuclear testing during the Cold War.[26] But radioactivity of the kind we worry about is not produced by nearly so many organisms, processes and activities as greenhouse gases, and its impacts (as of yet) have been limited.[27] Finally, volcanoes can affect climate at the global scale, but only for a few years.[28] One might venture the thought that humans can barely *think* at the scale of global warming—after all, we have never had to do so before.[29] More specifically, the reason we must live within an absolute limit of GHG emissions, why Broecker's carbon pie is finite, is the enormous difference of temporal scale between fossil fuels and other sources and sinks of atmospheric CO_2. When a grassland burns, it releases carbon that was sequestered just 1-10 years before. The carbon released by a forest fire was sequestered decades or at most centuries ago. With fossil fuels, by contrast, sequestration occurred *hundreds of millions* of years ago; 6-8 orders of magnitude greater than with plants, 5-6 orders of magnitude greater than with soils. These disparities are critically important when evaluating ways to reduce atmospheric CO_2 concentrations because planting trees can only sequester carbon until the trees die, and although carbon can stay in soil for centuries, the soil must remain unplowed. As the Keeling Curve shows, atmospheric CO_2 concentrations oscillate every year due to the aggregate effects of *all* the vegetation on earth; the curve drops by 5-6 ppm during

---

[24] See, e.g., W.J. Mitsch et al. 2001. *Reducing nitrogen loading to the Gulf of Mexico from the Mississippi River Basin: strategies to counter a persistent ecological problem*. BIOSCIENCE 51: 373-388. C. Huang, L.D. Norton and D.C. Flanagan. 2009. *Challenges in linking agricultural soil erosion studies to landscape scale processes.* GEOPHYSICAL RESEARCH ABSTRACTS 11: 10142 (at: http://www.ars.usda.gov/research/publications/publications.htm?seq_no_115=236013).

[25] A. Sornette and D. Sornette. 1989. *Self-organized criticality and earthquakes*. EUROPHYSICS LETTERS 9: 197-202.

[26] See R. Wolfson. 1991. NUCLEAR CHOICES: A CITIZEN'S GUIDE TO NUCLEAR TECHNOLOGY. MIT Press, pp. 60-63. E. Welsome. 1999. THE PLUTONIUM FILES. Dell Publishing.

[27] R.L. Murray. 2003. UNDERSTANDING RADIOACTIVE WASTE. 5th edition. Battelle Press.

[28] A. Robock. 2000. *Volcanic eruptions and climate*. REVIEW OF GEOPHYSICS 38: 191-219.

[29] It is rather like the revolution produced by geology when it became irrefutably clear that the earth was not thousands but billions of years old—only this time we're dealing with the future rather than just the past, and with a problem whose implications are practical rather than merely intellectual, theological or doctrinal. This time, our understanding is not the only thing at stake.

the northern hemisphere's summer, when plants there absorb CO_2 in photosynthesis, then it rises as plants senesce and decay in the winter. The point is that compared to the magnitude of the longer-term trend—atmospheric CO_2 is already more than 100 ppm above pre-industrial levels—the potential of vegetation to address climate change is an order of magnitude too small.

This is *not* to diminish the significant role that deforestation plays as a source of CO_2 emissions at present,[30] but rather to point out that *no matter what happens to forests, it happens on a temporal scale completely different from that of fossil fuels*. Although the CO_2 from both sources mixes readily in the atmosphere, and has equivalent GWP, the two carbon cycles should be seen as distinct for purposes of policy. Efforts to prevent deforestation, or to plant new forests, *cannot* scale up sufficiently because trees simply do not live long enough. A protected forest will still die and release its carbon, and a planted forest will do the same, but it will be too soon to effectively 'cancel out' the release of CO_2 from fossil fuels. The only way around this problem would be to cut down the trees before they die and permanently remove them from contact with the atmosphere—by sinking them in the deep ocean, burying them on land, or shooting them into space. In other words, as long as fossil fuels continue to be burned at rates that exceed the capacity of sinks to absorb the resulting emissions *at a comparable temporal scale*, [31] atmospheric concentrations will continue to increase. Carbon offset and credit trading schemes that fail to account for these scale differences are destined to fail, at least if we look more than 10 or 100 years down the road. Unfortunately, this applies to virtually all such schemes at the present time.

In the absence of a technological silver bullet, such as the one Broecker envisions, the inescapable conclusion is that *we need to leave as much coal, oil and gas in the ground as possible, for as long as possible.* To say that this is politically impossible does not make it any less true. At the very least, it should be the point of departure for all negotiations and debates, as anything less is a potentially fateful concession.

III. The Built Environment

Policy informed by this conclusion must focus on what geographers call *the built environment*: buildings, systems of transportation, energy and communications, water, sewage and waste management facilities, farms,

---

[30] *See* Yadvinder Malhi et al., *Climate Change, Deforestation, and the Fate of the Amazon,* 319 SCIENCE 169, 169 (2008) (noting Amazonian forests "removal by deforestation can itself be a driver of climate change and a positive feedback on externally forced climate change").

[31] The only sinks of this temporal scale are the deep oceans—which are already absorbing roughly half of human-produced CO_2—and geologic formations deep underground.

factories, schools and hospitals, etc.[32] The built environment "functions as a vast, humanly created resource system, comprising use values embedded in the physical landscape, which can be utilized for production, exchange and consumption."[33] Pacala and Socolow have famously argued that a rapid, comprehensive reconfiguration of the world's built environment has the potential to do what Broecker considers impossible; namely, "to meet the world's energy needs over the next 50 years and limit atmospheric CO_2 to a trajectory that avoids a doubling of the preindustrial concentration."[34] What this would require is not so much new technologies, they argue, but an aggressive and enormous scaling up of existing technologies in transportation, energy, buildings, agriculture and land use.[35]

The built environment of the U.S. both presupposes and reinforces high rates of GHG emissions. Its construction itself produced significant emissions, and its design reflects the relatively cheap cost of energy during the twentieth century. The built environment is also what enables—and in many ways compels—American per capita emissions rates to be among the highest in the world.[36] The two largest sources of GHG emissions in the U.S., for example, are electricity generation and transportation, for which coal and petroleum, respectively, are by far the major fuels.[37] In both cases, consumers have only limited scope of influence. They can reduce their electricity use and drive more efficient automobiles, but the power plants, streets, and highways they rely on are fixed in place and largely beyond their control, and freight trucking exceeds passenger vehicles as a source of GHG emissions in any case.[38] One of Pacala and Socolow's "stabilization wedges" involves doubling the average

---

32 *See* DAVID HARVEY, THE LIMITS TO CAPITAL 233 (1982) (describing aspects of the built environment).

33 *Id.*

34 S. Pacala & R. Socolow, *Stabilization Wedges: Solving the Climate Problem for the Next 50 Years with Current Technologies.,* 305 SCIENCE 968, 968 (2004).

35 *See id.* (noting these technologies have passed beyond laboratories and many are already being used in industry).

36 *See* The Conference Bd. of Can., Environment: GHG Emissions Per Capita, http://www.conferenceboard.ca/hcp/ details/environment/greenhouse-gas-emissions. aspx#_ftn3 (last visited Nov. 3, 2009) (noting that among developed nations, only Australia and Canada have higher per capita GHG emissions than the US).

37 *See* U.S. Envtl. Prot. Agency, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2007, Executive Summary (2009), http://www.epa.gov/climatechange/ emissions/usinventoryreport.html, (last visited Oct. 21, 2009) (reporting that electricity generation accounted for 42 percent of CO_2 emissions from fossil fuels in the US in 2007; transportation accounted for 33 percent. They accounted for 34 and 26 percent, respectively, of all US GHG emissions). *See also* Lee Chapman, *Transport and Climate Change: A Rev.,* 15 J. OF TRANSPORT GEOGRAPHY 354, 355 (2007) (concluding that this pattern holds across the developed world).

38 *See* Chapman, *supra* note 15, at 356 ("[T]he major contributor is road freight which typically accounts for just under half of the road transport total.").

efficiency of automobiles,[39] a daunting task, but relatively easy in comparison to other wedges. Reducing vehicle miles by fifty percent,[40] for example, would entail reorganizing the geographical distribution of homes, businesses, schools, and so forth.[41] Another wedge would require improving the energy efficiency of all buildings by 25 percent.[42] All three of these measures together would still achieve less than half of the necessary reductions, as a total of seven wedges is required to keep the concentrations at twice pre-industrial levels in 2050, and further steep reductions would still be necessary after that point.[43]

Whether built and owned by governments or private firms, the components of the built environment have a number of things in common. First, they tend to be very expensive to build, and still more so to replace. The interstate highway system, to give just one example, is estimated to have cost nearly $129 billion.[44] Second, these costs generally must be absorbed up front, before revenues can be generated from their use.

The built environment, therefore, depends heavily on financial instruments and institutions that permit large scale borrowing and long-term amortization. The total outstanding state and municipal debt in the U.S., which is mostly comprised of long-term bonds issued to finance investments in the built environment, was $1.85 trillion in 2005.[45] From this, it follows that the built environment must persist, not just physically but economically, far into the future, if the bonds, mortgages and other debt instruments are to be successfully retired. "Roads, railways, canals, airports, etc., cannot be moved without the value embodied in them being lost."[46] As geographer David Harvey notes; "immobile physical and social infrastructures . . . are crafted to support certain kinds of production, certain kinds of labour processes, distributional arrangements, consumption patterns, and so on."[47]

Finally, the built environment is not only a very complex and expensive investment, but also the 'habitat' in which people live, with

---

39 *See* Pacala & Socolow, *supra* note 12, at 969 (raising fuel efficiency from 30 miles per gallon to 60 miles per gallon).

40 *See id.* (suggesting another potential wedge).

41 *See* Chapman, *supra* note 15, at 364 (concluding that in the short term "policies to change behavior and travel habits are more important than technological solutions") (citing Anable, J. & Boardman, B., *Transport and* CO_2. (U.K. Energy Research Centre, Working Paper, Aug. 2005)).

42 *See* Pacala & Socolow, *supra* note 12, at 969 (noting yet another wedge option).

43 *See id.* at 968 (pointing out the exact number of necessary wedges depends on annual carbon emissions growth).

44 *See* U.S. Dep't of Transp., Dwight D. Eisenhower National System of Interstate and Defense Highways, http://www.fhwa.dot.gov/programadmin/interstate.cfm , (last visited Oct. 21, 2009) (estimating the cost since 1958).

45 *See* Fed. Reserve Bd., Flow of Funds Accounts of the United States: Flows and Outstandings First quarter 2006, 123 http://www.federalreserve.gov/releases/Z1/20060608/z1.pdf (last visited Nov. 9, 2009) (containing the assets and liabilities for the flow of funds).

46 HARVEY, *supra* note 10, at 380.

47 *Id*. at 428.

profound effects on both thought and behavior. Expectations about resource use, for example, how warm or cool one's house should be, how frequently to bathe, what counts as waste, or how far it is reasonable to travel for work or pleasure, are all deep-seated dispositions formed by long-term interactions with one's built environment. These dispositions are highly variable depending on economic and cultural resources, and they are subject to change. But they are, nonetheless, persistent. In geographical parlance, the built environment produces space-time; it is naturalized as the taken-for-granted and normal.[48] This means that changing the built environment is as much a social and psychological challenge as it is a physical and financial one.

Taken together, these characteristics make the built environment the site of a complex interplay of inertial physical structures and financial instruments, on the one hand, and dynamic transformations, on the other. The dynamism stems not only from processes of physical wear and tear, which may or may not be countered by ongoing investments in maintenance and repair, but also, and more rapidly, by the interrelatedness of each component with the others. "[S]ince the usefulness of individual elements depends, to large degree, upon the usefulness of surrounding elements, complex patterns of depreciation and appreciation . . . are set in motion by individual acts of renewal, replacement or transformation."[49] The situation is compounded by the fact that privately owned components of the built environment, such as homes and factories, have asset values that float in the market, and their owners have a strong interest in protecting those values.[50]

It is clear that the U.S. built environment must be changed, rapidly and radically, if we are to address global warming. But we cannot easily write it off and start over. We are too heavily invested in it, financially and otherwise. This predicament holds at every scale from households, small businesses and municipalities up to national governments and transnational firms. It offers the best lens, I believe, through which to understand the obstacles and opposition to effective climate policy in the US.

IV. Devaluation: By Policy or by Climate?

As fixed capital, the built environment is subject to *devaluation*, not only from ordinary use and physical deterioration but also from social and

---

48 *See* DAVID HARVEY, JUSTICE, NATURE, AND THE GEOGRAPHY OF DIFFERENCE 222–23 (1996) (explaining the social construction of space and time).

49 HARVEY, *supra* note 10, at 234.

50 *See* Freddie Mac, Freddie Mac Update: October 2009, 9, http://www.freddiemac.com/investors/ pdffiles/investor-presentation.pdf (last visited Nov. 7, 2009) (finding that US single family mortgage debt totaled $10.4 trillion as of June 30, 2009; equity in those homes was less than debt ($9.6 trillion)).

economic processes operating on larger scales.[51] Neighborhoods decline, factories become obsolete, for reasons that may be entirely independent of their particular physical characteristics. The market value of an inefficient car or home will drop as energy prices rise. Although we tend to notice these dynamics most when they are abrupt and painful, they are not anomalies. On the contrary, they are an intrinsic feature of capitalism, with observable geographical patterns. "The total effect is that place-specific devaluations become more than just a random, accidental affair . . . . The devaluations are systematized into a certain spatial configuration . . . . The continuous re-structuring of spatial configurations through revolutions in value must again be seen, however, as a normal feature of capitalist development."[52] When devaluation occurs via market mechanisms it is widely viewed as a necessary, if unfortunate, price of progress, for which no one can be held responsible.[53] Not so when the cause can be identified as the conscious act of a political body; no one wants their durable assets, from SUVs to container ships, devalued by regulatory or legal mechanisms.

In a fortuitous paradox, however, climate change renders this view of our predicament simplistic and misleading. Directly or indirectly, global warming is going to devalue our current built environment anyway.[54] It is not a question of whether, but when and how it will happen. Hurricanes are projected to become more intense due to rising sea surface temperatures, threatening coastal cities with abrupt destruction such as occurred in New Orleans and along the Gulf Coast during Hurricane Katrina in 2005. Sea-level rise poses a similar threat, with impacts that are more gradual but also more widespread and permanent.[55] Increasingly severe weather events such as floods, droughts and heat waves promise to stress our existing systems for providing water and shelter, with potentially deadly public health impacts.[56] As glaciers retreat and snowpack declines, large populations and economies face enormous costs to build or retrofit dams, reservoirs, and aqueducts to store and convey adequate water supplies. Agricultural investments face possible devaluation from shifting climatic conditions and more frequent or intense pest outbreaks. We cannot know how soon or how abruptly devaluation by climate change will take place for any given location, but it is clear that we should expect it to happen on a time-scale of decades, not centuries. These impacts will be highly uneven between regions, and generally more

---

51 *See* HARVEY, *supra* note 10, at 425 ("[D]evaluation is a social determination.").

52 HARVEY, *supra* note 10, at 426.

53 *See id.* ("The continuous re-structuring of spatial configurations through revolutions in value [is] . . . a normal feature of capitalist development.").

54 *See generally* R. L. Wilby, *A Rev. of Climate Change Impacts on the Built Env't,* 33 BUILT ENV'T 31 (2007).

55 *See id.* at 33 (rising sea levels pose a problem for cities).

56 *See id.* at 38–40 (discussing the effect of climate change on the world's water resources).

severe in the poorer parts of the world,[57] but they will force changes in the built environment virtually everywhere, sooner or later, if human societies are to adapt.

The policy implications are far-reaching. The question becomes not whether widespread devaluation will occur, but how: by the effects of climate change, or by intentional, deliberate policies? This should be viewed not so much as a crisis but as a political opportunity. If we assume that 2-5 percent annual reinvestment in the built environment is a normal necessity under any circumstances, then in 20-50 years we can expect it to turn over in its entirety. This may or may not be fast enough to avoid all, or even most, of the impacts of global warming, but it is a logic that everyone should be able to understand, regardless of political or ideological leanings. If *every* decision we make regarding the built environment is made with climate change as a high priority, we may be able to anticipate, absorb, and in many ways control the processes of devaluation that are in store for us. Framed this way, there is no clear distinction between mitigation and adaptation; a built environment that produces fewer GHG emissions is generally also more resistant to rising temperatures, diminishing water supplies, and declining fossil energy inputs.

---

[57] M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson (eds). CONTRIBUTION OF WORKING GROUP II TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, 2007. Cambridge University Press.