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Climate Future: Averting and Adapting to Climate Change

by **Robert S. Pindyck**

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It is the author of this book that, together with his co-author, produced the outstanding microeconomics textbook (Robert S. Pindyck and Daniel L. Rubinfeld 2018) that became an unavoidable pillar of microeconomic education for economists around the globe. For the reader who is a trained economist, this textbook contribution demonstrates the capacity of the author to provide sharp, focused and thoroughly understandable analyses. Accordingly, the supply side appears promising to the reader even before turning the first page of the book. The demand for this sort of analysis perhaps cannot be any greater than in the case of climate future – climate changes, their sources and consequences – as public debate on this topic is too opinionated, biased and not evidence-based, and the loudest voices in the debate room (e.g. former presidents Donald Trump and Jair Bolsonaro) are by and large completely ignorant about the issue, and various celebrity activists (e.g. Greta Thunberg) are doing only slightly better in terms of understanding the ideas that they have been advocating. Hence, with a high-quality supply capacity and substantial and vibrant demand, the resulting equilibrium embodied in the book should be expected to be an outstanding publishing contribution.

At the very beginning of the book, the author spells out that the primary focus of his research has been on the nature and implications of uncertainty, and that the book is a response to the fact that many of the books, articles, and press reports that the general public read make it seem that we know a lot more about climate change and its impact than is actually the case. According to Pindyck, commentators and politicians often make statements such as that if we do not sharply reduce CO_2 emissions, the following things will happen – as though we actually know what will happen. However, the author points out that those things might happen, rather than they will happen, because our understanding of climate change is very bounded. Nonetheless, one of the possible outcomes is what the author describes as a climate catastrophe, and he argues throughout the book that the possibility of such a catastrophe should be the main driver of global climate policy. Well, an issue for the reader is that having finished the book they have gained no information on the probability of a catastrophic outcome, or on the loss of GDP/consumption and quality of life that should be considered as a climate catastrophe. That’s uncertainty at work.

According to the author, the book is about four sets of questions. “First, if the world continues to emit growing amounts of greenhouse gases (GHGs), what will happen to the climate over the coming decades? By how much will temperatures increase? What will warming do to sea levels, the severity and frequency of storms and hurricanes, the extent of droughts, and other aspects of climate? And, perhaps most important, what will be the economic and social damage resulting from these changes?” (p. 1). The gist is that we do not know much about the answers to each of those questions, and that is explained very well in the book. The second set of questions is about what should be done to avert climate change. “In particular, by how much and how rapidly should GHG emissions be reduced, and what policy tools should be used to achieve those emission reductions?” (p. 1).

The third set of questions deals with the situation that, while we might agree on what should be done, we need to ask what will be done to avert or reduce the extent of climate change. Even if we are optimistic about the likelihood of countries agreeing to major reductions in their GHG emissions, what emissions scenarios can we realistically expect to see? Is it reasonable to think that worldwide emissions will fall drastically and rapidly enough during the next few decades to prevent severe climate change?

Prior to the final set of questions, the author presumes that it is not realistic to expect global GHG emissions to fall sufficiently and quickly enough so that, despite our best efforts, we (or rather our children and grandchildren) are likely to experience higher average temperatures and rising sea levels. Then what should we do in response? Should we act now to avert or reduce the impact of likely climate change, given realistic emission scenarios, and if so, what should those actions be?

A basic assumption of the book is that “given the economic and political realities, it is simply *not realistic* to expect the kinds of GHG emission reductions needed to avert a substantial amount of global warming, and as a result, *we should take actions now to reduce the possible impacts of that warming*” (pp. 1-2, italics in the original). These actions the author refers to are various forms of adaptation.

The answers to the first set of questions deal with the fundamentals of climatology, and the basic mechanism of climate change is explained in the book. Emission of CO_2 increases the concentration of this gas in the atmosphere, and increased emission speeds up the increase in concentration. This concentration of CO_2 creates what is known as a “greenhouse” effect, trapping more heat (from the Sun and from the Earth’s surface), thereby causing an increase in average temperatures. Higher temperatures cause other changes in the environment and the climate, such as rising sea levels and heating seawater, producing higher ocean temperatures and contributing more energy to tropical storms and hurricanes, making them more intense and more destructive. Finally, a more destructive climate, due to the higher average temperatures, generates adverse effects on the GDP/consumption reduction, and a decreased quality of life (utility level) irrespective of consumption. Hence things are explained straightforwardly, based on the insights of modern science, and historical data is provided in the book, going back to 1950, demonstrating both the increase in average temperature by 1°C and an increase in the CO_2 concentration by about 40 per cent, with only diehard climate change deniers unconvinced of the causality chain.

The main problem is, as the author emphasises, that we know very little about the causality chain. We know that the direction of causality is from CO_2 emission to GDP/consumption and quality of life reduction, but the character and especially the parameters of this causality is something that we are only guessing – not only for one but for every link in the causality chain. For example, we are not sure about the parameters of the link from CO_2 emission to CO_2 concentration, because the dissipation rate of the gas, although definitely low, is not known for certain. We guess that 70 per cent of CO_2 stays in the atmosphere for about 100 years, but we do not know the exact period nor whether the period is stable or can be changed in one direction or the other by altering some other parameters, such as average temperature. We know that higher CO_2 concentration in the atmosphere leads to temperature increase but we do not know by how much (what is the elasticity, in economics parlance) and what is the time lag, so we obtained only the range of results: 10, 20, 30 or even 50 years. We know that an increased average temperature may have significant environmental impact, but we do not exactly know what it would be and what its magnitude would be. For example, it is expected that an increase in average temperature will raise sea levels, but it is uncertain what the rise will be for a temperature increase of 1°C: how many centimetres, inches, feet, or meters will the sea levels go up? Furthermore, what will be the impact of such an increase in average temperature on the warming of the oceans and consequently on the frequency and severity of hurricanes, typhoons and storms, as well as floods and wildfires? We do not know. Finally, even if we know what the environmental impact of global warming (for a given average temperature increase) will be, what will be its impact on GDP/consumption and quality of life? It is reasonable to assume that agriculture would be the industry affected the most[1], but the list is far from complete. What will be the effects of increased average temperature on labour productivity in all sectors? Investments in adapting to the ubiquitous and adverse environmental changes will possibly crowd out investments in productive sectors, production of goods and services for consumption, and the decline of consumption. Perhaps, according to the author, higher temperatures may also result in greater morbidity and mortality, because many harmful microbes and parasites thrive in warmer weather, and because very high temperatures may themselves are detrimental to quality of life and health. In short, even without decreasing consumption, the quality of life would deteriorate (Ian W. R. Martin and Pindyck 2021).

The most frequent sentence in the book is “We do not know”. A refreshing and honest approach of the author, sobering for the reader. This is especially so at a time when swats of climate activists, who throw substances on the masterpiece paintings or chain themselves to nets at prominent tennis events with substantial media coverage, claim they know everything. Pindyck is careful to explain the reasons for this fundamental ignorance.

The climate is a complicated dynamic system with a substantial number of internal links and feedbacks, and although virtually all of them are well-understood (courtesy of modern physics), they are notoriously difficult to measure or even to estimate for

[1] The same, although not mentioned by the author, goes to fishing industry, as the increased average temperature will warm the oceans, with possible adverse effects on marine life.

quantification. This is why climate change models, however sophisticated they may be, are based on assumptions about the magnitude and timing of some of the links and relations, rather than on data. Different assumptions about relevant parameters, which are applied in the models, lead to their distinctive results. In short, the results of climatological research, i.e. climate change models, are basically a distribution of results – the estimates, with a range, mean, standard error and interval of confidence. It is about probability, not about a definite answer. Furthermore, the probability is not specified, as there are too few observations (of the results/estimates) to enable the law of large numbers to work – probability cannot be specified *ex ante*.

Not only is there a colossal uncertainty about the magnitude and dynamics of climate change and consequential environment modification, as the consequence, but there is an even greater uncertainty regarding the economic effects of the climate/environment changes. Even if we knew what the expected climate/environment changes were, we simply do not know what their economic impact would be. As the author points out, we do not have any economic theory that the impact could be modelled on, nor any data for empirical testing of a theoretical models. Hence, the consideration of the economic impact of climate change is purely speculative. It is not for nothing that climate change is considered the ultimate challenge for economics (William D. Nordhaus 2019).

Since we know what we do not know (a reasonable first step), the reader should focus on what we do know, more precisely – what the reader learned from the book. The first and very important lesson is that there is substantial uncertainty about the outcome of climate change. The only thing that is certain is – uncertainty. We are not even able to associate a probability of the different outcomes (very good, good, reasonable, bad, very bad, catastrophic), in addition to not being able to specify those outcomes in economic terms, in terms of social costs of climate change. Accordingly, we are unable to calculate the expected value of the social costs of carbon (SCC).

Nonetheless, this conclusion means that a catastrophic outcome is possible – its probability is greater than zero. In other words, a catastrophic outcome of climate change is quite feasible. For the author, this insight is quite enough to build his case of climate policy as insurance against a catastrophic outcome. Pindyck uses an analogy. Although a household does not know whether catastrophic damage will happen to the home it owns and lives in, the household insures the home nonetheless, because catastrophic damage is feasible. The problem with this analogy is that in the case of home/house insurance, the household knows what is the magnitude of catastrophic damage and what is the probability of the damage, meaning that the information on the expected value of the loss is available, which together with the household's risk preferences enables it to specify the maximin amount of insurance premium that it is willing to pay. In the case of climate change, we know nothing about these parameters, hence we do not know what is the amount of the insurance costs that would be acceptable to us – basically the reservation price of climate policy. The reader can be convinced that we, as humanity, need an insurance policy against the worst-case climate change scenario, but still there is no information regarding the price that should be paid for it.

The second thing that we know, according to the author, is that the atmospheric concentration of CO_2, the most important GHG, is predominantly the consequence of human-generated CO_2 emission[2]. It is generated both in the production process (producing electricity in thermal power station, for example – in short, anything that burns carbon-based fuels, with additional emission in some specific production process, such as cement production) and in the consumption process (driving a car, flying aeroplanes when going to the vacation, or just heating the home in winter). It is economic growth that pushes up the level of output and consumption and in that way speeds up CO_2 emission. The increased emission has accompanied economic progress and the world population growth. Nonetheless, we also know – it has been empirically demonstrated – that the relationship is not linear. With the shift of economic activities to services, which are not as energy intensive, the amount of energy consumed per unit of GDP decreases, and with the introduction of innovative technologies this decreases the amount of CO_2 emission per unit of GDP, in some cases, economic growth need not increase the CO_2 emission. This has been demonstrated in the case of rich countries in the past decades. Nonetheless, in most countries, especially emerging markets, economic growth increases CO_2 emission. According to the data provided in the book, the greatest increase is recorded in China (an unsurprising result) and generally in Asian emerging markets, where economic growth is based on manufacturing. India's contribution is also substantial.

Taking all of author's rich insights into account, it is evident that there are substantial costs to reducing CO_2 emission, effectively slowing down economic growth, possibly making it negative, with a drop in consumption and human welfare. This is especially the case in countries that need economic growth more than others. And that is precisely the main reason for the controversies surrounding actions regarding climate change. What is the price and who will pay it? The problem is that climate activists simply do not care about answering these questions – they do not care about the costs. And their demands for immediate action can be reduced to absurdity. Yes, it is possible to eliminate CO_2 emission at once – just stop producing anything. Hardly a feasible solution!

Much more interesting is the author's notion that there are diminishing returns in CO_2 emission reduction. For example, converting power stations from coal-burning to natural gas- burning reduces emissions by half and is a relatively simple and not-so-costly technological adjustment. However, moving towards zero CO_2 emission is much more expensive, even when technologically feasible.

The third thing that we know is that climate change is a slow-burning process with substantial time lags. We know that the time lag between the increase in the CO_2 concentration in the atmosphere and the increase in the average temperature has been measured in decades, and the author picks 30 years as the most probable time lag. Then, there is a time lag between the temperature environment changes and their economic effects. Furthermore, we know that due to the low CO_2 dissipation rate, the increase in its concentration is virtually irreversible, even in the long run[3]. This means that the costs

[2] The author points out that this is not the case with other GHGs, such methane. For example, human-generated methane emissions account for only about 60 per cent of total methane emissions; methane is also emitted naturally from wetlands, oceans, permafrost, and other sources. The problem with methane is that higher average temperature increases non-human-generated emission, hence, a vicious circle exists. Again, we do not know the parameters.

[3] The author accepts the estimate (based on data on the emission and concentration starting from 1950) of

of climate change will come in the future and that the costs of reducing CO_2 emission must be borne now and in the near future. Considered from another viewpoint, the costs of not acting now will be borne in future, and the costs of future benefits (of moderate climate change or no change at all) are to be borne at the present. In short, there is an intertemporal, effectively intergenerational dimension to costs and benefits, opening the issue of the discount rate. The author emphasises that decision-making with regard to public policies (including those aimed at climate change) is taking care of the welfare of the constituency in the present and extremely near future, and that the efforts of lobby groups have the same time horizon, leading the reader to conclude that effectively the discount rate is substantial. Too bad for the next generations.

The fourth thing we know is that only the global emission of CO_2 counts, not the emission from any (specific) country. In short, the emission of CO_2 (together with the global warming that it generates) is a supranational issue. Nonetheless, the public policies that should deal with the emission are national – it is national governments that make decisions about them, and it is their constituencies that bear the cost of these policies (e.g. carbon tax). This discrepancy creates a problem of coordination, as there is a strong incentive for free riding – let the other nations bear the costs of reducing CO_2 emission and let us reap the benefits. International agreements should allocate the emission reduction effort to every country and provide an enforcement mechanism. Then, a suitable criterion for allocation of effort must be found, taking into account that emerging markets generate the greatest CO_2 emission, but also that on a *per capita* basis, the greatest emission still comes from the rich countries. It is rich countries that commit to net zero CO_2 emission in foreseeable future, but that does not help unless emerging markets are at least on the path towards such an emission.

How can CO_2 emission be reduced? The author identifies four possible mechanisms: (1) carbon tax; (2) tradable CO_2 emission caps, i.e. cap-and-trade scheme; (3) regulation, i.e. government mandates; and (4) subsidies. Pindyck's favourite is the carbon tax: basically a Pigouvian tax that internalises external costs, in this case – the social costs of carbon (SCC). The carbon tax will undoubtedly make burning carbon and CO_2 emission due to other industrial processes more expensive and provide an incentive for economic agents to adapt by switching to non-carbon technologies. According to the author "[a] carbon tax is efficient, effective, and simple" (p. 103).

Nonetheless, there are a few problems regarding this policy, some of them mentioned by the author. The first one is that the optimal Pigouvian carbon tax should be levied according to the social costs of CO_2 emission, but the author has demonstrated that we do not know the magnitude of these costs (Pindyck 2013). Furthermore, even if the magnitude of the SCC were known, they would be borne in the future, hence the issue of discount rate is still open. The author's way out of the conundrum of how large the tax should be is simple. "In the U.S., any tax would be better than what we have now" (p. 145). This is hardly proper guidance for a carbon tax policy. Especially considering that the author suggests that "carbon tax – as opposed to subsidies or government mandates – can help overcome the free-rider problem and achieve a binding

0.35 per cent per year dissipation rate, meaning that about 84 per cent of any CO_2 emitted today will remain in the atmosphere 50 years from now, and 70 per cent will still be around 100 years from now.

international agreement" (p. 139). Not very convincing insight, taking into account the recommendation about the magnitude of the carbon tax burden, as well as issues regarding the free-rider problem in climate policy (Nordhaus 2015).

Nonetheless, the author is well aware that carbon tax is extremely unpopular and hence not politically feasible. It is a pity that Pindyck does not explain this unpopularity. It is about very simple microeconomics of tax burden. Because the demand for many products (goods and services) based on carbon burning is inelastic, the tax incidence is such that the tax burden is passed to the consumers in the form of higher prices, decreasing the purchasing power of income, and reducing consumption. The adjustments that will eventually convert production to non-carbon technology take time, with uncertain effects on the price, but in the short-run, the drop in consumption due to the carbon tax is inevitable. This was the reason for the Yellow Vest protests in France (*Mouvement des gilets jaunes*) and would be the cause for similar protests in virtually every country in the world.

Hence, it is rather curious that the author stands by a policy recommendation that is, in his own words, not politically feasible, at least not in the foreseeable future. It is also rather odd that the author dismisses the cap-and-trade policy, something that is not only politically feasible but that has also been enforced in the EU for years. A rather simple mechanism of emission quotas enables every economic agent with capped CO_2 emission to adjust. Those who are CO_2 inefficient may buy additional quotas on the market, and those who are CO_2 efficient may sell some segment of the quota allocated to them and generate additional revenues. The secondary market for the quota creates the market price of the CO_2 emission/pollution and a short-run adjustment of economic agents, improving economic efficiency. The author claims that the disadvantage of the cap-and-trade scheme is that it does not decrease CO_2 emission but only caps it. Nonetheless, that can be solved with a long-run decreasing cap, along the lines of RPI-X price regulation in the case of natural monopolies. As to the allocation of the quotas to the economic agents, this can be done via auction, to prevent any kind of lobbying, as demonstrated in the EU. The author claims that the US companies would resist paying for the CO_2 emission permits, which may be true, but the relevant question (not tackled by the author) is which of the two mechanisms, carbon tax vs cap-and-trade scheme, is more likely to be political (in)feasible. From what has been presented in the book, the reader would bet on the cap-and-trade scheme as being more feasible[4].

It is compelling, nonetheless, that neither a carbon tax nor a dynamic cap-and-trade scheme will decrease CO_2 emission sufficiently, hence a policy of government mandates is a useful supplement in many cases. Nonetheless, mandates are administrative measures, so they must be set for the future, providing a reasonable period for all producers to adjust to these mandates, such as the final year for selling new non-electric vehicles or a deadline for shutting down coal-burning power stations. Another important issue is government credibility regarding the mandate set for the future. Any adjustment

[4] As demonstrated by Julius J. Andersson (2019), in the case of Sweden, carbon tax and cap-and-trade scheme can coexist and produce an efficient outcome. Nonetheless, the result for Sweden should not be generalised to other counties, without specific Swedish taxation preferences, confidence in their government, stringent tax culture and efficient tax administration.

of the mandate, once it has been set, would undermine creditability, therefore the entire process must be carried out very carefully.

The author believes that production and consumption subsidies in the case of net zero CO_2 emissions products are distortive, hence they are only suitable for research and development (R&D) in the field of net zero CO_2 emission and related technologies. He applies, quite reasonably, a standard economic argument of spillovers, i.e. positive externalities. These subsidies are needed because new, improved technologies, primarily for producing electricity, should be applied in order to reduce CO_2 emission. According to the author, it is highly desirable that the substantial technological breakthrough occurs in the area of storage of electric energy, since even improved, more efficient wind power or solar power facilities are inherently intermittent renewable energy sources (IRES) and substantial energy storage must be provided for the period of low supply, due to darkness or low winds. In short, more efficient power storage, both in technical terms and costs, is the linchpin of IRES becoming the backbone of zero CO_2 emission electricity producing system. The author suggests that the world should embrace once-discredited nuclear energy and that the public should overcome the fear of nuclear plant accidents (Three Mile Island, Chernobyl, Fukushima). Naturally, innovations in that technology, especially in terms of safety (i.e. more reliable and less accident-prone operation and used fuel processing and storage) are welcome. Above all, there should be strong price incentives – such as a carbon tax and/or a dynamic cap-and-trade scheme – for economic agents to abandon carbon-based fuels and switch to net zero CO_2 emission technologies.

Taking all these elements into account, the author provides a highly speculative scenario in which net zero global CO_2 emission is achieved by the end of this century, or even earlier. According to his back-on-the-envelope calculation (the only thing that can be done, taking into account all the uncertainties in this case), the concentration of the GHG gases (both CO_2 and methane) would be such that there is, according to Pindyck, a strong likelihood that average temperatures will increase not merely by 1.5°C or 2.0°C by the end of the century – but rather by 3.0°C or even more. Is this outcome inevitable? Well, there are ways of reducing CO_2 concentrations in the atmosphere. One is natural – trees. The problem, however, is that the process requires many trees, many more than exist at the present and deforestation has been ongoing, clearing land for agriculture. In short, reforestation (to compensate for deforestation) and afforestation (to increase the stock of trees) are not viable options. The other option is a technology of CO_2 removal for the atmosphere and its sequestration. Unfortunately, according to the author, the technology is in its infancy and has substantial problems – it will probably be inefficient and expensive to use for the foreseeable future.

Taking all this into account, the only option is adaptation to the consequences of global warming, possibly with an average temperature increase of 3.0°C or even greater. There is a long list of the things that can be done, including "developing new crops that can resist extreme temperatures, adopting policies to discourage building in flood-prone or wildfire-prone areas, building sea walls to prevent flooding, and the use of geoengineering to reduce the greenhouse effect of a rising CO_2 concentration" (p. 171). The list is long. Some of these adaptation measures are intuitive, such as developing new heat resistant crops, but the author's valuable point is that the R&D development of the new crops should start now as the innovation path is unpredictable and with a significant number of dead ends. Policies to discourage building in flood-prone or wildfire-prone areas, as such areas will undoubtedly expand due to the increase in average temperature and sea levels, are mainly focused on removing subsidies for insurance premiums for such real properties, so that the developers and owners would bear the full costs of premiums, i.e. a price of insurance proportional to the flood and wildfire risk. Such policies are not controversial in themselves, but it is uncertain to what extent it will be effective.

More controversial is building sea walls, dikes and levees as adaptation to the rising sea levels. The endeavour is not technologically controversial, the technology has existed for centuries, and it is well-proven, but comes with a hefty price tag. As an example, the planned sea wall that would protect only southern Manhattan from a storm surge with higher sea levels would cost, according to the author, around 119 billion USD. And that is only part of Manhattan. Furthermore, the author points out the adverse environmental impact of such barriers that have already been identified, and that sea walls may endanger the natural barriers against flooding.

Perhaps the most controversial policy or rather method of adaptation is solar geoengineering, with a rather simple approach: "seed" the atmosphere with sulphur dioxide, at an altitude of roughly 20 kilometres. These "seeds" would remain in the atmosphere for up to a year, after which time they would precipitate as sulfuric acid and fall back to earth. While in the atmosphere, the particles would reduce the greenhouse effect by reflecting sunlight back into space. The author emphasises that all of the CO_2 in the atmosphere will remain there. The only thing the sulphur dioxide will do is cause the atmosphere to reflect more sunlight, which will nullify some of the harmful warming effects of the CO_2. In short, solar geoengineering deals with the consequence, not with the source of climate change – it is the last bastion against global warming.

The costs of solar geoengineering are rather modest, and it can be done by a single rich and technologically advanced country (e.g. the USA), so there is no need for global action, only global agreement on the policy is desirable. Nonetheless, solar geoengineering has a substantial adverse environmental impact because of the recurrent acid rain that it generates. Although it is evident that such an impact would exist and would be significant, it is uncertain – again – how bad it would actually be, especially in the case of the rising acidity of the oceans. Nonetheless, the author rightfully points out that R&D on the implementation of solar geoengineering, e.g. the development of a stratospheric aircraft that could carry out the sulphur dioxide seeding, is the way to go – the sooner, the better.

Insurance is the keyword in the book, and according to the author it should be the key to our (global) climate policy. The bottom line is that, with so many uncertainties, the world should insure itself against the worst, catastrophic climate change, which could be an existential threat to humanity in the future. The author makes his case for the need for insurance and offers many types of insurance policies, emphasising that "wait and see" is, because of the time lag and irreversibility, the most dangerous attitude. The reader is convinced that developing stratospheric aircraft capable of solar geoengineering seems like a good insurance idea for the beginning or rather for the end, if everything else fails.

The author did a great job in rising the awareness of the educated public to climate change and providing a spectrum of policies in a very readable book for non-specialists – you do not have to be a climatologist or economist to understand the points and messages of the book, unlike in the case of contributions in specialised academic economic journals (Geoffrey Heal 2017; Nordhaus 2019). Some examples in the book are even so trivial that the reader's impression is that the author sometimes underestimates the readership[5]. There is abundant food for thought in the book and the author offers generous guidance for future reading, with an extensive reference list for anyone who wants to follow up. This is an outstanding publishing contribution.

In the years to come we will undoubtedly learn more about climate change and the uncertainty will decrease, though not be eliminated. Nonetheless, the issues mentioned in the book, such the free-rider problem, political economy constraints and high discount rates, are here to stay, and it seems that things must first get worse, much worse before they can get better. So, it would be good to have that stratospheric aircraft on the tarmac, ready for action when the time comes, if it comes. After all, better safe than sorry.

[5] Just a quote from the book for illustration. "Suppose the weather is sunny and warm, so you plan a relaxed day at the beach. You arrive when it's low tide, so you set a chair down in the sand, and start reading that book you just bought. But now the tide starts to come in, so what will you do? If you just sit and keep reading your book, you'll eventually find yourself under water. So you get up and move your chair farther back on the beach. That's adaptation" (p. 171).

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