The human measure

Quotation p. 11

It is ten thousand years ago and spring has arrived. The gleaming ice cap that covers Scandinavia is melting like snow before the sun and the Baltic Sea rushes to fill the space that has fallen vacant. The sea level is rising rapidly, and more and more land that lay dry during the ice age is now coming under water. The seals who wintered off the coast of Portugal for a hundred thousand years, as long as the North Sea remained dry, swim back to the Wadden Sea. The polar desert of Northwest Europe suddenly turns green. Insects carry plant seeds northwards, and one by one the trees return from their warm refuge behind the Alps: first the birch, then the pine, later the oak, and finally the beech. It is a race to see who will get there first: the lighter the seeds, the faster they travel.

Our forefathers shed their fur cloaks, polish off the last of the mammoths and, in the ever greener Middle East, think up ways to get around the constant need to search for new hunting areas and fishing grounds. They sow the tastier grass seeds together in square plots, and discover that this enables them to produce much better food. Their invention soon conquers Europe. Plants, animals, human beings: all come under the spell of a climate that is rapidly becoming warmer.

It is now the height of summer. We humans have developed into a successful but worrisome breed. Although the climate is almost constant, we are still fearful that a century from now it may be a degree warmer. The sea level is barely rising, but we act as if it represents a major threat to our lives. Thanks to the invention of agriculture ten thousand years ago, we are able to multiply to our heart's content, but we take pills to prevent this. We worry about the diversity of the plants and animals around us, but never before have we been surrounded by so many different species. In our fields stand Iraqi grain, Mexican corn, and potatoes from the Andes; our gardens are filled with tulips from Turkey and rhododendrons from Madagascar; we have aquariums full of tropical fish, and there's an insatiable demand for exotic pets. We worry about the disasters that regularly befall us, but in many cases these events are catastrophic only because we have chosen to live on the edge of the volcano, on the active fault lines, on our crumbling coastlines and overflowing

rivers. We have cut down the forests so that the rivers now have to transport more water; we have dug up the peat so that the land now lies under sea level, prey to the water. We have become a tribe of worrywarts with a guilty conscience.

But that guilt is a luxury, a luxury that stems from the fact that, without realizing it, we are living in the summer of time. Now, at summer's height, Nature is gracious and allows us to busy ourselves with negligible climate peaks and vague ripples on the surface of our seas. We see nature solely in terms of our human measure. But ten thousand years from now autumn will be upon us. And that will put an end to the euphoria. The ice caps will return, and the sea level will drop again. The seals will have to head back to Portugal, the rhododendrons will freeze in their garden plots, and the anti-fur activists will take refuge beyond the Alps. Volcanoes will erupt with a force never before seen in the brief history of human civilization. Only then will it dawn on us that the measures of nature far exceed our human measure.

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Why is it that no one has stopped to consider this? Why is it that we are blindly passing on all future problems to the next generation? I can already hear the protests: But that's not true! We're extremely concerned about the future, and we constantly take into account the needs of the generations to come. We're striving for a sustainable world. According to the Brundtland Rapport, sustainability consists in 'meeting the needs of the present generation without compromising the ability of future generations to meet their needs.' Oh, really? And how many generations does that cover? Just how long does sustainability last? Well, our grandchildren must also be in a position to benefit from our prosperity, is the answer. Has there ever been a better example of the smallness of the human measure? Grandchildren! In other words, everyone who has a living recollection of us must be assured of a good life – otherwise they'll blame us for squandering the earth's resources. Two generations. Fifty years. And what happens after that is not our problem. Am I wrong? Let us look at the report published by the Club of Rome in 1972, 'The Limits to Growth'. It contains an interesting chart showing the space and time scales of human vision. What does it tell us?

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'Well into the future' means the life span of the children, on the horizontal axis. The year 2100 is their horizon, as is borne out by the rest of the report. Even the Iroquois thought further ahead

than that: their chiefs were obliged to take into account the future consequences of their deeds down to the seventh generation. If a generation lasts twenty-five years, that would take us right up to the year 2200. But one of our biggest suppliers of predictions, the Intergovernmental Panel for Climate Change (IPCC), is not yet prepared to go that far. Let's take a look at their charts. The graphs below, which represent the prognoses for temperature changes and rises in sea level, are arguably the two models most often cited in relation to the climate discussion. These are sophisticated models. And yet they still don't go beyond 2100. Since the Club of Rome, no one has dared to look further into the future. In fact, we've actually taken a step backwards, since we are now thirty years closer to 2100, apparently the sell-by date of their predictions.

Of course, I understand why they haven't gone any further. Their curves fan out like a swarm of bees from the hive: they are so divergent that any predictions extending further into the future would simply be too unreliable. We can't even predict the weather ten days in advance. Beyond that, everything is uncertain. ##

But even if we are not able to predict what the weather will be like a month from now, we can say with certainty that autumn will follow on summer. And for that we don't need to know what kind of weather we'll be having in two weeks or a month. It's enough to know that there is a larger-scale cyclicity, namely the orbit of the earth around the sun. And this astronomical cycle has also existed for over four and half billion years. So regardless of whether it's rainy or sunny two weeks from now, autumn will arrive, and it will be followed by winter. The only thing we don't know is whether it will be a mild or a severe winter.

In the same way, the climatological height of summer in which we now live will be followed by a gradual cooling, a prelude to the next ice age. And for that we don't need to know whether it will be warmer or colder in 2100 or 2200 than it is now. The alternation of ice ages and warm periods is governed by the same kind of astronomical cycle as that of summer and winter: the Milanković cycle. But then on a larger time scale. Our climate completes a full cycle in a hundred thousand years, a process that has been going on for over four and a half billion years. The global warming of recent years cannot prevent the coming of the next ice age any more than it can hold back the seasons. As a result of human intervention, the following ice age may be less extreme than it would otherwise have been, more sluggish perhaps. But it will come. And just as we know when winter will set in, we can calculate exactly when the next ice age is scheduled to start: 23,000 years from now. Roughly a thousand generations.

A politician thinks about the next election, a statesman thinks about the next generation. But who thinks about the next thousand generations? No one. This book is a plea to start thinking further ahead. We humans are very clever when it comes to looking backwards, examining the

history of mankind, the history of the planet. But why don't we look a bit further into the future? Yesterday, today was tomorrow. We don't have to go all the way to the death of the sun and the cooling of the earth, which are scheduled to take place billions of years from now. For the moment, we can even forget about the year 802,701 from *The Time Machine* by H.G. Wells. Instead, let us look a mere ten thousand years into the future, making use of what we now know about earth processes.

And just why would we want to do that? Well, in the first place, because by then a number of trends which we now see heading in one direction, such as climate warming, may then be going the other way: towards the next ice age. We're looking at a larger section of a cycle lasting many years, one which at the moment exceeds our human measure. And with that long-term knowledge in the back of our mind, we might take different short-term decisions. The people living on the planet four hundred generations from now may well be quite happy with all the carbon dioxide we're sending into the atmosphere, since it will make for a milder autumn.

In the second place, we want to look further ahead in order to get a better grip on catastrophic natural phenomena. It is a fact that the more violent an event is, the less often it occurs. The larger the earthquake, the eruption, the flood, or the meteor shower, the longer it will be before the next event of such magnitude comes around. An earthquake measuring 8 on the Richter scale is ten times as powerful but also ten times as rare as one measuring 7: a logarithmicrelation. Of all the deadliestdisasters which have taken place throughout our geological history, not one of them has occurred in the brief space of time during which Man has been recording his history. They, too, exceed the human measure. But the generations to come will inevitably be confronted with such catastrophes.

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And why ten thousand years? The last psychological milestones in our theories about the future, George Orwell's 1984 and the magical year 2000, are both part of the past. The period in which we now live, the Holocene, began ten thousand years ago. That was the 'spring' with which this chapter opened, and we know from the geological history that warm periods such as ours seldom last longer than ten thousand years. So it's about time we started thinking about autumn. Not only that, but the storm surges that Holland's sea dykes were designed to withstand also occur about once every ten thousand years. River dams must have a life span of ten thousand years. Volcanoes that last erupted less than ten thousand years ago are regarded as active. In the United States, radioactive waste must remain undisturbed in its underground bunkers for ten

thousand years. And our close relative, the little man from Flores, became extinct only slightly more than ten thousand years ago.

Thinking in generations is by definition thinking according to the human measure. But we will have to learn to think in the logarithmic measure of nature: not in periods of a hundred years, but ten thousand years. And not one scale unit at a time, i.e., a thousand years, but two units, or ten thousand years. For over a period of ten thousand years, there is at least a reasonable chance that events with a repeat time of a thousand years will actually take place.

For most people, ten thousand is an abstract number. 'Ten thousand years!' they say. 'Isn't that just like a geologist, always going on about millions of years'! But those same people have no objection to winning a million euros in the lottery, and then they are very much aware of the difference between ten thousand and a million euros. Of course, they can rely on special advisers who help them deal with the fact that they are suddenly a million dollars richer. Sometimes I feel just like one of those advisers, but then one whose job is to help people grasp the immensity of geology's greatest gift to mankind: deep time.

It is 1968. Outside, the student revolution is in full swing. I'm in the lab, looking into a microscope at thin slices of sandstone. Jagged grains of sand, sediment from a large desert river that long ago flowed where now the Pyrenees lie. Then a detail catches my eye. I reach for a stronger lens and focus on a clear, round grain of quartz. Inside the tiny grain something is moving. 'This is impossible', is my first thought. This rockis 250 million years old and as dead as a doornail. But what I'm seeing is not a stray ant or aphid on my slide. It's inside the slice of sandstone, inside that grain of quartz. An even stronger lens. Within the quartz is a minute hollow which is filled with a liquid. And in that liquid is a minuscule red ball. The ball is dancing around, without aim or direction, propelled by tiny invisible currents. As it has been doing for the last 250 million years. I forget about my lab session, my assignment, and the other students, and for the first time I slide into the fathomless depths of time.

It is not only the sheer length of time that makes it difficult for people to look far ahead, but also the way in which earth processes proceed over time. Three of those manifestations of time form the basis of the present book: time as flow, time as wave, and time as pulse.

The first manifestation – time as flow – is probably the simplest. The history of our earth is an ongoing process, an irreversible sequence of events. And each of those events has its origin in previous events, like radioactive decay or the expansion of the universe since the Big Bang. And each one always proceeds in a single direction, since one thing follows upon another. Just as

people used to think that because evolution results in ever more complex forms of life, it would inevitably produce that jewel of creation: Man. This is what Stephen Jay Gould calls time's arrow, in his book Time's Arrow, Times Cycle (1987). And this does indeed come closest to the way Man experiences time. Another birthday, another year older. Life is hard and then you die. Time marches on, time flows, you can never step into the same stream twice, *hora ruit, tempus fluit*.

But there are also physicists, among them the Belgian Nobel prize winner Ilya Prigogine, who claim that time as arrow does not exist, and that past and future can only be distinguished from one another by an observer. So perhaps there was no need for me to write this book after all.

The second manifestation – time as wave – is about cycles: the circulation of the blood, breathing in and breathing out, day and night, summer and winter, ice ages and warmperiods. All of these consist of cycles. The earth turns on its axis, the earth revolves around the sun. Water from the ocean evaporates, forms clouds from which rain falls, which flows back to the ocean, completing the hydrological cycle. The tectonic plates which make up the earth's crust move towards one another, collide, and separate again: the tectonic cycle. Lava streams out of an erupting volcano, rain and wind erode the rock until it disintegrates into sand and clay, rivers transport it to the sea, where it is buried deeper and deeper under younger layers; then it starts getting warmer, ends up between two colliding plates, melts, turns into magma, rises up through the earth's crust, and is reborn as lava which streams out during a volcanic eruption: the rockcycle. There is also a carbon cycle, a nitrogen cycle, etc., etc. This is what Gould means by time's cycle. The earth always returns to the same departure point: there is no beginning and no end. The Greek word *kuklos* means circle, but in the case of time there is of course no question of returning to one's point of departure. Time simply continues on its way, becoming a wave-like movement in two dimensions or a spiral in three. A wave on the water surface is a perfect illustration of how a circular movement can be translated into a wave.

The third manifestation is time as pulse. The history of our earth is an untidy sequence of sudden pulses of energy: earthquakes, meteor showers, eruptions, floods, extinctions and other catastrophes, with no direction, purpose, or regularity. When someone who believes in coincidence is struck by disaster, he asks himself in despair: Why me? Why my loved ones? Why these vulnerable individuals? Why now? He does not think in terms of a necessary development or a recurring cycle of predictable events. He sees nothing but arbitrariness and chaos: earth time as disaster scene.

In this book I demonstrate how currents, waves and pulses, on time scales ranging from minute to immense, come together to create a masterly musical composition. One in which the measure of Man is limited to the occasional three-quarter time. The human measure.

In the next chapter we will examine three examples of how during the twentieth century Man was caught unawares by the sudden reversal of trends in nature, in each case as a result of changes in the sea level of the Caspian Sea. In the chapter which then follows we see how mankind – from biblical figures to the nineteenth-century forefathers of geology – has always had problems with the depth of geological time, and the nature and duration of geological processes. In each of the subsequent chapters we will follow natural processes – flows, waves, and pulses – in the form of earthquakes, volcanism, climate changes, sea level, rivers, evolution, and meteor showers. These phenomena range from small and frequent to large and rare, from inconsequential to so menacing and catastrophic as to be almost beyond our comprehension.

This should not be seen as an attempt to warn readers about the apocalypse and the end of mankind. Many people have already done so, and history shows that most of them were mistaken. On the contrary, I maintain that Man is quite capable of adjusting to warmer or colder climates, and higher or lower sea levels. If Stone Age man was able to survive an entire ice age with no more than bear hides and stone hatchets at his disposal, then does our highly developed technology not equip us to deal with a rise in sea level of one paltry metre? And that while the sea level in the Westerschelde rises four metres twice a day? Perhaps we should be thinking about what to do when the sea level starts to drop again. It won't be another ten thousand years before that happens.

CAPTIONS

Page

11 Márquez …(Take from English translation of the book)

13 The human measure.

14 Man's field of vision. Although the field of vision of many individuals differs in space and time, the involvement of each human being can be indicated on a space-time chart. The majority of people are only interested in things that affect family and friends, and then only over a limited period of time. Others look further ahead in time or further afield – to a city or a country. But very few people have a worldwide field of vision, and one that reaches well into the future. Meadows, 1972. (I'll try to find the original text, pending)

16 IPCC prognoses of temperature changes and changes in sea level up to the year 2100. Watson et al., 2001.

18 Climate curve of the last hundred and fifty thousand years, extrapolated to the next twenty-five thousand years. Imbrie and Imbrie, 1979, Skinner and Porter, 1987.

20 Time, in half-lives

Time as flow: radioactive substances decay at a constant speed; after one half-life, only half of the original number of atoms is left, after two half-lives a quarter, etc. The half-life of uranium-238, the most important radioactive element in the earth's crust, is four and a half billion years, which is also the age of our earth. Thus of all the uranium present when the earth came into being, one-half is still in existence.

21 Time as wave: the wind sets the water particles moving in a circular direction, creating a wave on the surface of the water. http://epswww.unm.edu

22 Time as pulse: seismogram of an earthquake.

23 Ten thousand years from now the North Sea may look like Death Valley today.