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-Viewpoints-

History of Kitakyushu along with the great divergence in Anthropocene: An implication for possible periodization

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Abstract

Anthropocene meaning the epoch of the human activity is a newly recognized geochronological epoch starting from the beginning of industrial revolution, which became visible due to acceleration of the accumulation of emitted materials or chemicals which are listed as the characteristic parameters of the epoch of anthropogenic impacts. Here, we view that the beginning of Anthropocene in Asia could be dated back to the year of 1901 when the first steal making facility in the nation-owned Yawata Steel Works was established in Kitakyushu area for the first time in Asia. Since then the Japan entered into Anthropocene followed by other Asian countries with some decades of delay. In the present report, based on the analyses of the demographic and industrial structural changes found in Kitakyushu city as a model city where Asian Anthropocene originated, we propose a possible periodization of Anthropocene in Japan starting from 1901, through trisection of the epoch into the early, the middle and the late ages, corresponding to the half century prior to the second world war (WWII), the post-WWII half century reflecting the great divergence of Anthropocene, and the decades post 2000 including coming future years characterized by intensive, greener, and sustainable human efforts, respectively.

Keywords: Anthropocene, Industrial history, Japanese industrialization, Kitakyushu, Meiji era, SDGs

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Introduction:

Today, many believe that we live in the very lasting geochronological epoch called Holocene starting from approximately 11,650 years ago (according to radio-carbon dating) up to the present time (Walker et als., 2009). However, as discussed earlier in this journal (Kawano, 2019a), biologists and environmental chemistry specialists started to oppose the idea that Holocenic world is intactly maintained without being disturbed by the mankind (through a variety of anthropogenic activities) even under the conditions that industrial and traffic impacts on environments such as climate changes are drastically increasing year by year. According to Eugene Stoermer, a biologist (Revkin, 2011) and Paul Crutzen, an environmental chemist (Steffen et al., 2011), today, our world seems to be positioned in the middle of Anthropocene, a newest epoch started from the beginning of industrial revolution (dating back to the late 18th century).

Holocene is the epoch in which human species survived and thrived through hunting, fisheries, and primitive agriculture. In contrast, the industrial revolution coincides the time that people in urbanized areas started non-vocational hunting, fishery and horticultural activities not for survival but just for fun or as leisure (Kawano, 2015). In fact, the timing of industrial revolution also coincides with the age of enlightenment movement in Europe (spanning from the late 17th to the early 19th centuries, peaking at the late 18th century) through which interdisciplinary scholars seamlessly covering mathematics, physics, chemistry, and biology cooperatively contributed to the development of modern science which could be the basis for the technological advancement required for industrial revolution (Kawano, 2018).

Taken together, it is tempting to view that the way of thinking and the way of life have been drastically altered by people basing in urbanized area. Not only because the acceleration of urbanization (measured as the increase in urban population) is one of the key parameters of Anthropocene (Steffen et al., 2011), the role of the urbanization helping maturation of the culture reminds us of possible importance of the industries backed by the modern science emerged in the urbanized regions in Europe, when discussing the factor determining or triggering the onset of Anthropocene.

In general, the growth of Anthropocenic parameters looks slow in the early phase following industrial revolution in United Kingdom, until the end of the Second World War (WWII). However, it was followed by notable increases in all of the parameters representing the progress of Anthropocene such as the burst of global population and the anthropogenic changes in environments being impressively accelerated after 1950s. By definition, Anthropocene is the epoch represented by the overwhelming anthropogenic impacts on environments, thus the discussions on the future environmental situations and human survivals must be inevitably related to the planned and controlled growth of anthropogenic activities.

Today, scientists actively warn that the Earth will be further challenged by increasing industrial and traffic activities due to growing human populations, thus threatening the natural environment, chiefly biodiversity and carbon sequestration (Abel et al., 2016; Marques et al., 2019). A number of scientists are now encouraging the public and government actions for preventing the global climate changes triggered by the anthropogenic impacts, based on the confidence shared among the certain portion of scientists, that the growth of global human population and associated economic activity could be gently lowered by fully implementing the eco-friendly actions and sustainable developmental goals (SDGs) proposed by United Nations (Abel et al., 2016; Kawano, 2019a).

Kitakyushu city is the Asia's first city introducing the heavy industries chiefly the first modern steel works installed in 1901 (with aids from German engineers), and with some delay, introducing massive ceramic and chemical industries. Due to overly intensive installation or development of industries, the city of Kitakyushu has once severely suffered from the heavily polluted waters, airs and soils in the past (peaked in 1960s). However, this city is now considered as one of the world-leading eco-friendly and/or sustainable cities pioneeringly and continuously acting for environmental protection and installation of sustainable systems in the society.

In 1985, the Organization for Economic Co-operation and Development (OECD) evaluated the environmental achievements made in Kitakyushu city in its White Paper on the environment, and described Kitakyushu city as a city that transformed itself from a 'Grey city' into a 'Green city.' For confirming the improvement in the atmospheric environment in Kitakyushu city, in 1987, the Environment Agency in Japan has listed Kitakyushu as one of the Starry Towns/Cities under clear atmospheric environment. Furthermore, in 1990, the city of Kitakyushu was conferred the 'Global 500 Award' by the UN Environment Program (UNEP). Notably, in 1992, Kitakyushu was awarded for its environmental leadership at the Earth Summit held in Rio de Janeiro, Brazil.

As reputed above, the government of Kitakyushu city is now considered as one of the most influential local governments leading the world trends for the shift towards the sustainable societies as endorsed by OECD which selected Kitakyushu city as one of four Green Growth Model Cities (2011) and one of six SDGs-promoting cities/regions (2018).

Therefore, it is tempting to take a closer look on the history of Kitakyushu city typically experienced the positive and negative aspects of intensive industrialization and eventually shifted to the eco-centrically driven society, along with the progress of Anthropocene representing the overwhelming anthropogenic environmental impacts threatening us and thus driveng us for the shift to the sustainable way of life.

Birth and growth of Kitakyushu city in the last century

The world has not been simultaneously and evenly industrialized after the onset of industrial

revolution. According to the historical view, the industrial revolution could be dated back to 1779, the year that the construction of the world first iron bridge crossing the River Severn in Shropshire, England, was initiated (Briggs, 1979; Cossons and Trinder, 1979). In Asia, the earliest introductory step for heavy industry could be dated back to the 5th of February, 1901, when the Higashida First Blast Furnace composing Yawata Steel Works, designed by German engineering firm (Gute Hoffnungshütte) was tooled in a region called Yahata later forming the core of Kitakyushu city, started its operations for the first time in Asia. For memorizing a series of historical events installing modern industries in Japan, the remaining facilities and buildings constructed during the Japan's industrial revolution (referred to as Japan's Meiji Industrial Revolution as it took place in Meiji era according to Japanese Imperial periodization) chiefly the compositions of the nation-owned Yawata Steel Works have been listed as a group of world heritages in 2015, after acceptance at 39th UNESCO World Heritage session (UNESCO).

Possible periodization within Anthropocene in Japan viewing through the changes in Kitakyushu city

While Anthropocene started in 18th century (1779) in Europe, 1901 must be memorized as the year of the onset of Asian Anthropocenic social changes, since then, the heavy industry installed in Japan showed rapid growth peaking in the years prior to the WWII. After installation of the steel works in a fishery rural where no one other than fishery people used to live surrounded by less densely populated village of Yawata (presently known as Yahata-Higashi ward), the area showed accelerated population growth up to the beginning of WWII (Fig. 1a).

After Japan, Manchuria was the second region to be highly industrialized by installing iron and steel industry (between 1932 and 1944; Rogers, 1948). The rest of Asian countries (especially in East Asia, later in South East Asia) showed drastic growth in industry mostly after WWII, thus the history of Anthropocene was mostly short-cut there and these countries entered the stage of so-called Great Divergence or Great Acceleration of Anthropocenic growth without any run-up period. Such timing of the onset of Anthropocenic growth could be the first point of periodization to be discussed.

Interestingly, the birth of Kitakyushu city as one of four rapidly developing major industrialized areas in Japan, along with the nation-wide post-war trends of great economic growth, coincides the acceleration of the globally on-going increases in 24 Anthropocenic parameters (Steffen et al., 2011), thus, contributing to "Great Divergence" symbolized by construction of great buildings and large-sized facilities made of concrete or metals.

In Kitakyushu area (corresponding to the present Kitakysuhsu city), Kokura (central) Station was relocated, and Kanmon national highway tunnel (3.6 km-long undersea tunnel across the Kanmon channel between Honshu Island and Kyushu Island) opened in 1958; Kokura castle tower was rebuilt

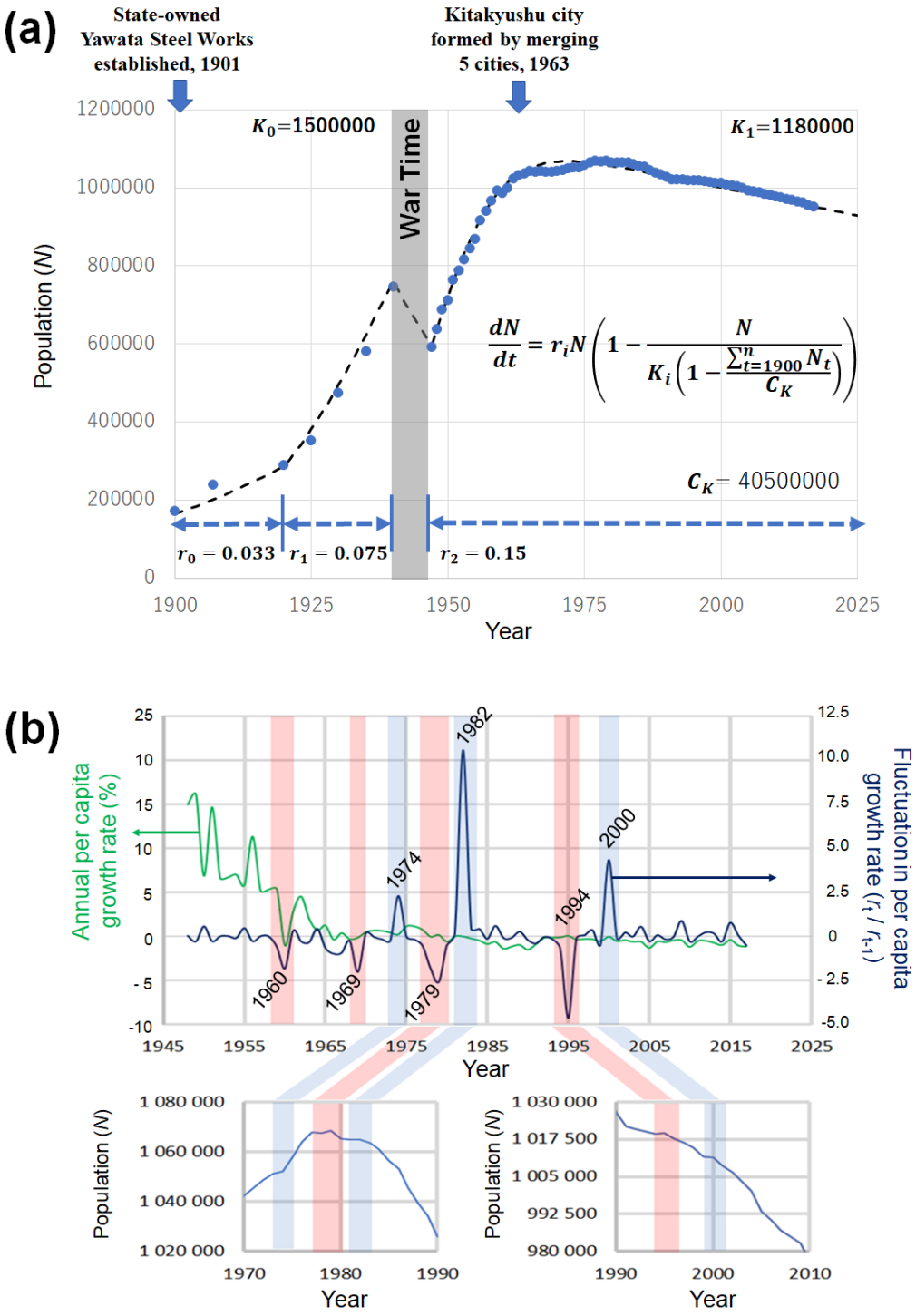

Fig. 1. Population of Kitakyushu city and former corresponding regions. (a) Demographic curve made from the data available from the Kitakyushu city's web page (https://www.city.kitakyushu.lg.jp/). The population of the corresponding regions in 1901 is based on the description by Katayama (2014). (b) Positive and negative fluctuation in the population growth rate in Kitakyushu area after WWII.

in 1959; a great steel-made suspension bridge connecting Wakamatsu ward and Tobata ward across

the Dokai Bay (Great Wakato bridge; 82.4 m in height, 627 m in length) was constructed and opened in 1962 just prior to the birth of the new city of Kitakyushu which was formed after 5-city-merging in 1963.

Under the administration of the new city, National highway bypass opened in 1966; the new city hall tower was built in 1972; Kitakyushu airport opened (renamed from Kokura airport), the Worker's Hall was built, Rainbow Plaza Hall opened, and Kannon Great Bridge (141 m-high steel-made suspension bridge, across the 1 km-wide Kanmon channel) was constructed and opened in 1973; the largest gymnasium hall opened in 1974; Sanyo Shinkansen line (a network of high-speed railway line connected at Kokura station) opened, the second Kanmon 3.6 km-long undersea tunnel opened, a new library hall opened, and the central wholesale market opened in 1975. Similarly, constructions of huge structures continued for further 15 years (Time table to be shown in the coming follow-up report).

In Fig. 1a, demographic growth in Kitakyushu area after 1900 are shown and the actual data plotted with closed circles are compared with the curves (dotted line) of simulated growth based on the Logistic model with a modification. Logistic equation is a mathematical model designed for simulating the demographic or ecological population curves (Takaichi and Kawano, 2016; Kawano, 2019b). It seems that population growth in Kitakyushu city obeys the modified Logistic model except for the period under the strong influence of WWII (1941-1947, showing a constant decrease equivalent to -3.34% of annual growth). Curve fitting suggested the growth rates to be used in the Logistic model could be trisected into 0.033 (3.3% for the period between 1900 and 1920), 0.075 (7.5% for 1921-1940) and 0.15 (15% for 1948-present), suggesting that the size of economy supporting the growth of the region was step-wisely doubled as the local economy shifted from industrial incubating period to the era of nation-wide economic growth as Japan emerged out as a new economic power before WWII, and the post-war recovery phase. Under steady growth rate after WWII, population of Kitakyushu showed maturation and started gradual shrinkage. Here, modification applied to the model defined the carrying capacity (K) determining the upper size limit of population as a changeable factor which is as a function of industrial capacity. The simulation shown here is designed to show shrinkage of carrying capacity (K) if the economic supply and/or stock from the old industry (the above-mentioned industrial capacity) becomes restricted or running out.

After merging of 5 cities to form the brand new Kitakyushu city in 1963 (as the first national government-ordinance-designated city in Kyushu Island), ironically the whole population in the region ceased growing and the population started to decrease after the peak recorded in 1975. Fig. 1b highlights the years showing the large size of sudden fluctuation in per capita growth rate against the trends of demographic change, which might be reflecting the conflicts between the population-elevating policies and the population-lowering economic pressure.

Shift towards the sustainable way of life

The above-mentioned fluctuations shown as the spikes were recorded in 1982 (the biggest), 2000 (the second biggest), 1994 (the third in size), 1979 (the 4th in size), and so on. The fluctuation recorded in 1979 reflects the sudden slowing in the rate of growth and the rest of large signals recorded

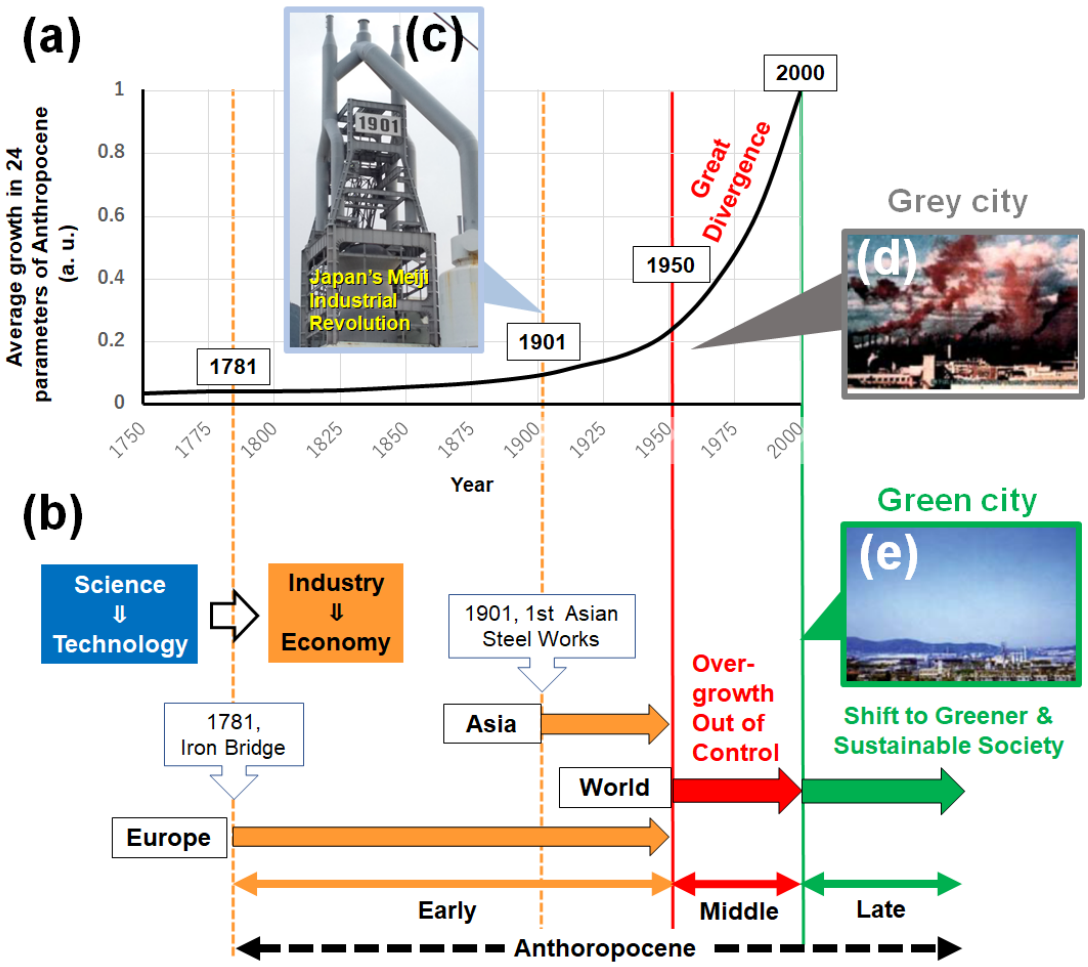

Fig. 2. Possible periodization of Anthropocene in Japan. Photos are from Kitakyushu city's official website. (a) A curve representing normalized increase in 24 Anthropocenic parameters (Steffen et al., 2011). (b) Possible periodization within Anthropocene trisected into three distinct ages, namely, the early age (1781-1950 in Europe; 1901-1950 in Asia), the middle age (1950-2000, corresponding to Great Divergence), and the late age (2001-present corresponding to greener and sustainable society). (c) Higashida First Blast Furnace vitalized in 1901 which is now preserved in Kitakyushu city. (d) Scenery of Kitakyushu city in 1960. (e) Scenery of Kitakyushu city today. Images shown in (d) and (e) were provided by the city of Kitakyushu.

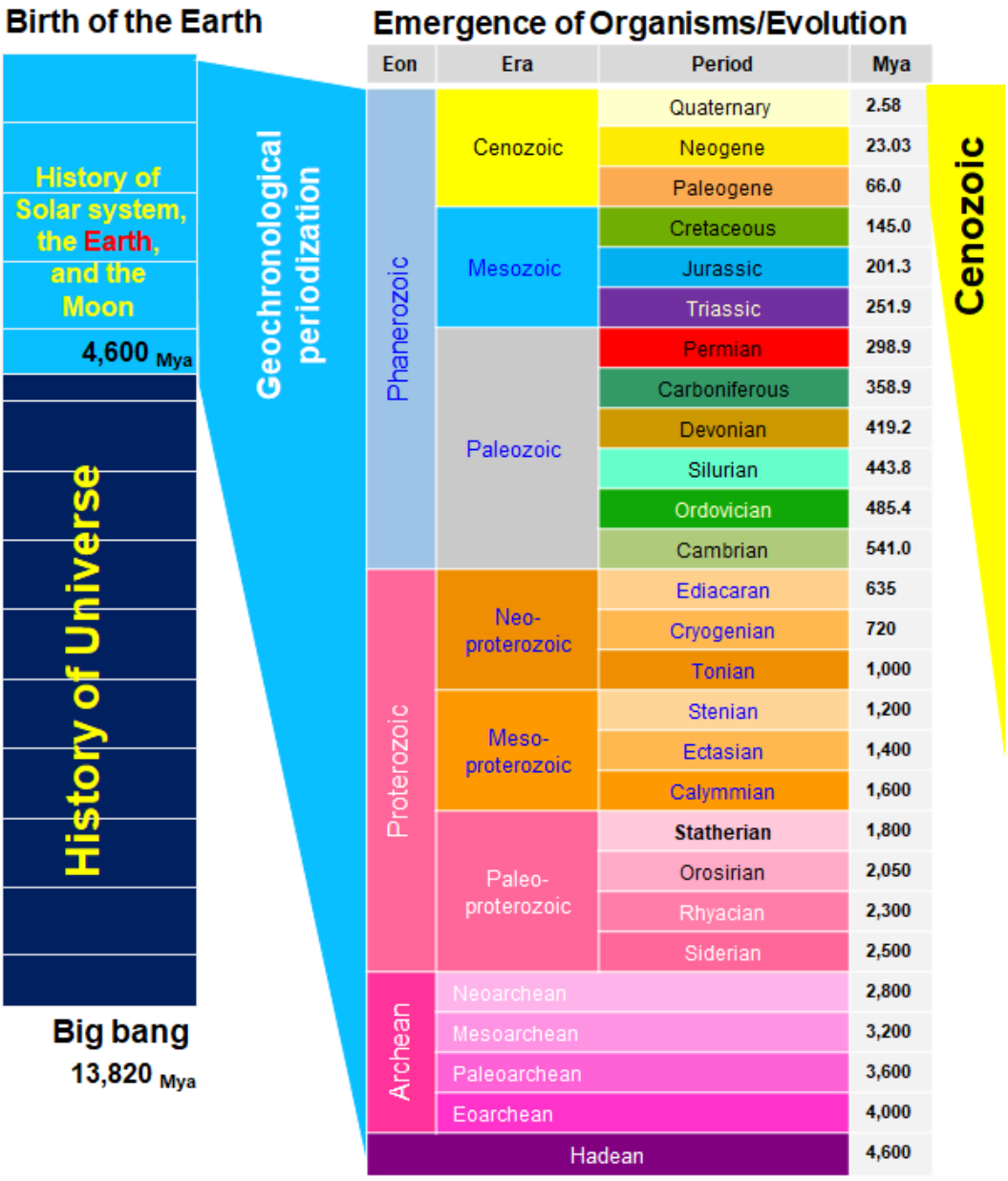

Fig. 3. Viewing Anthropocenic Ages through astronomical and geochronological time scales. Big bang to the birth of the Earth (left) and geochronological periodization (eons, eras, and periods) from Hadean eon to the quaternary period in Cenozoic era (right) are compared. Figure continues to next page.

in 1982, 1994, and 2000 represent the sudden increases in population against the decreasing trends immediately followed by re-decreasing in the population, suggesting that there were some temporal efforts such as local government's local economy-targeted policies.

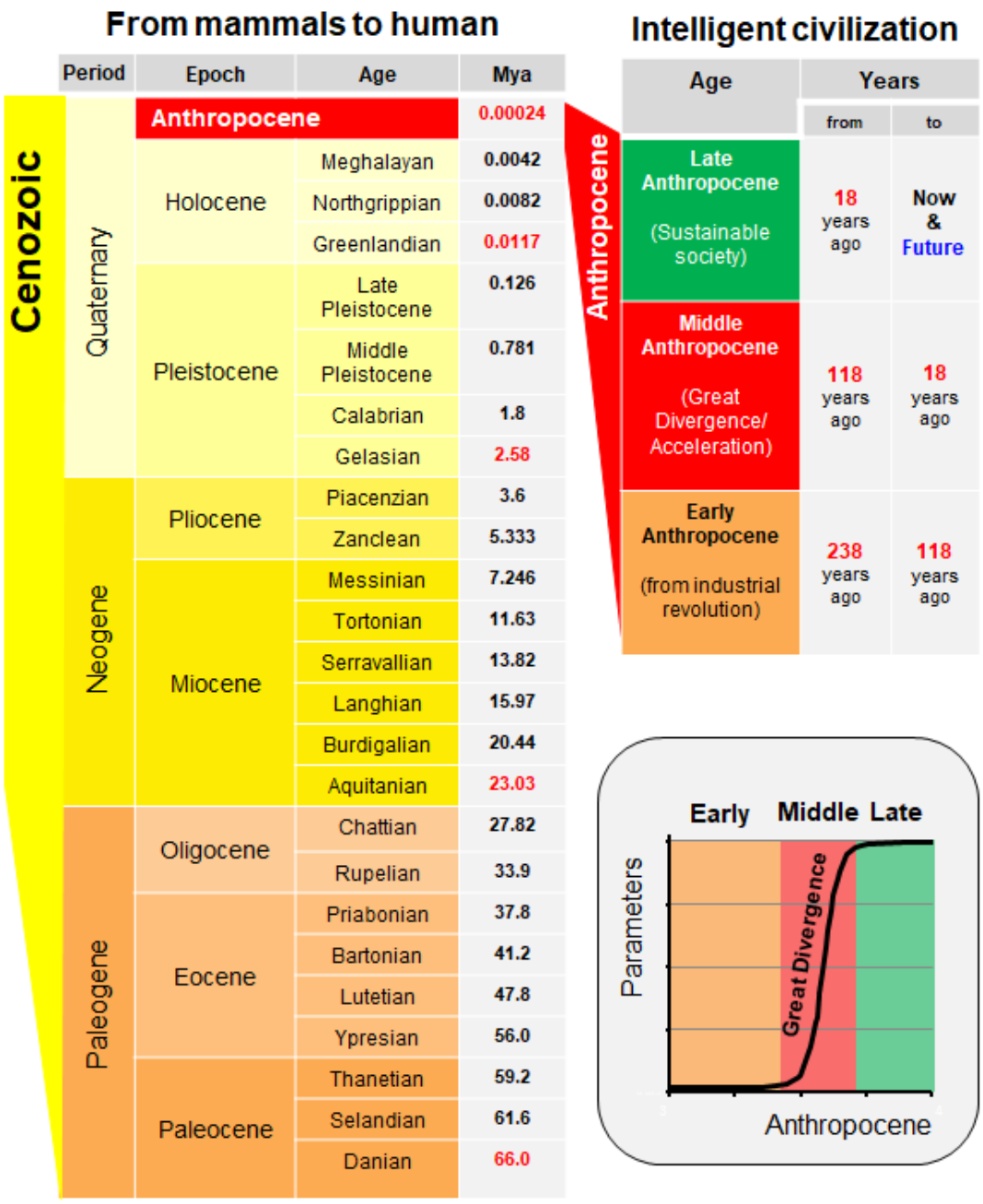

Fig. 3. Continued. Details of periodization (periods, epoch and ages) within Cenozoic era from Danian age in Palenocenic epoch (within Paleogene period) to the latest Anthropocenic epoch (within quaternary period)) are shown (left). Trisection of Anthropocene into three tentative ages, namely the early, the middle, and the late Anthropocene ages are proposed (right). In the inset, progress of Anthropocene through three tentative ages are plotted against the parameters of Anthropocene such as the global population .

Here, we view that Kitakyushu city showed a blue-print model for future societies in the world,

in order to shift towards the truly long-lasting sustainable civilization. With this respect, we would like to propose a possible periodization within Anthropocene as illustrated in Fig. 2.

After the last two major fluctuations recorded in 1994 and 2000, the population curve became smooth straightforwardly showing minute decrease without any major fluctuation. In fact, the last fluctuation in population (in 2000) coincide the efforts of Kitakyushu city to perform structural change in local economy to launch the eco-centric and environmentally-friendly industries instead of old heavy and/or chemical industries. This could be a sign that the city of Kitakyushu actively attempted its transformation from the heavy-industry-dependent structure into the eco-centric model economy. This point will be covered in a planned follow-up reading (by K. Nakao).

In 2001, the former mayor of Kitakyushu city, Mr. Sueyoshi deliver the message to the citizens (Koyama, 2012), by emphasizing the point that from then on Kitakyushu city lives the way of its life as "the eco-advanced city with citizens taking responsibility for maintaining the clean air and water by paying the necessary costs," in the middle of the city-held memorial event called "*Kitakyushu Hakuransai* 2001" cerebrating the 100 years of iron and steel-based industrialization in Kitakyushu, in front of the refurnished structure of Higashida First Blast Furnace decorated with a pair of metal plates on each of which "1901" the memorial year of steel industry installation in Japan was printed (Fig. 2c). This was a kind of farewell message to the old industries by converting "iron and steel" into mealy some kind of monuments and parts of history, and instead, a new sustainable way of life was to be chosen. The efforts made in Kitakyushu resulted in recovery of healthier urban environments with clean air and water as representative photos comparing the sky above the city in 1960 and one day after 2000 (Fig. 2d and e; photos provided by the environmental department of Kitakyushu city).

Fig. 2 (a and b) compare the curve synthesized from the above-mentioned 24 Anthropocenic parameters and possible periodization within Anthropocene which was trisected into three distinct ages, namely, the early, the middle and the late ages. In Japan, the early age should be dated back to 1901 while European counties entered into it from 1781. Beginning of the middle age Anthropocene corresponding to so-called Great Divergence might have started in most countries uniformly from 1950's. Here, we are proposing additional section of Anthropocene to be added as the late age starting from this millennium, which must be the greener and sustainable age, by viewing from the historical point and also with strong wishes for coming generations of mankind.

Expanding the view to the cases in the world

In Fig. 3 (spanning two separate pages), the sequence of astronomical and geochronological periodization in macroscopic and microscopic scales, starting from the big bang forming the universe towards the emerging sub-epoch ages in Anthropocene.

The idea that Anthropocene in Japan could be trisected into three sub-epoch ages might be also applied universally to the cases in the rest of world. To date, dissection of Anthropocene into the early

run-up period and the dynamic period represented by the steep, almost diverging increases in various environmental and economic parameters referred to as Great Divergence is largely accepted (Steffen et al., 2004, 2011). Although all the Anthropogenic parameters look divergent by the end of previous millennium or even today, they must be eventually revealed to have hidden convergent values to be attained in this finite world as discussed earlier in this journal (Kawano, 2019a). Therefore, we would like to name the newly emerging or coming phase of maturity and sustainability as the additional sub-epoch age (the late Anthropocene) as illustrated in the inset in Fig. 3.

Interestingly, there is a series of signs that Great divergence is gradually ceasing, at least in part. In North America and Europe, consumption of paper (one of Anthropocenic parameters) showed decrease after 2007, and valleyed in 2009, followed by slight regrowth in 2010 and 2011; and there is steady trends gradually lowing the rate of paper consumption between 2012 and 2015 (Haggith, 2018). This is a good sign that there is a global trends minimizing the consumption of forest resources (unfortunately with exception for the paper market in Asia which is responsible for nearly half of the global paper consumption). Such reduction my be due to ongoing science and technology revolution (Kawano, 2005), allowing the society to shift from the dependence to printed materials to the digital display. Since 26% and 7% of global paper consumption are for printing/writing and news print, respectively (Haggith, 2018). Therefore, global paper consumption could be further reduced by 33% if the society were completely digitalized.

Conclusion

Anthropocene is a newly recognized geochronological epoch starting from the beginning of industrial revolution. In this article, we presented our view that the Anthropocene in Asia can be dated back to the year of 1901 when the steel and iron industries are installed in the Northern tip of Kyushu Island in Japan. In addition, we propose a possible sub-sectioning of Anthropocene into three sub-epoch ages corresponding to (1) the run-up period prior to WWII, (2) the post-WWII half century reflecting the Great Divergence of Anthropocene, and (3) the decades (or even centuries) after 2000 characterized by intensive, greener, and sustainable human efforts.

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