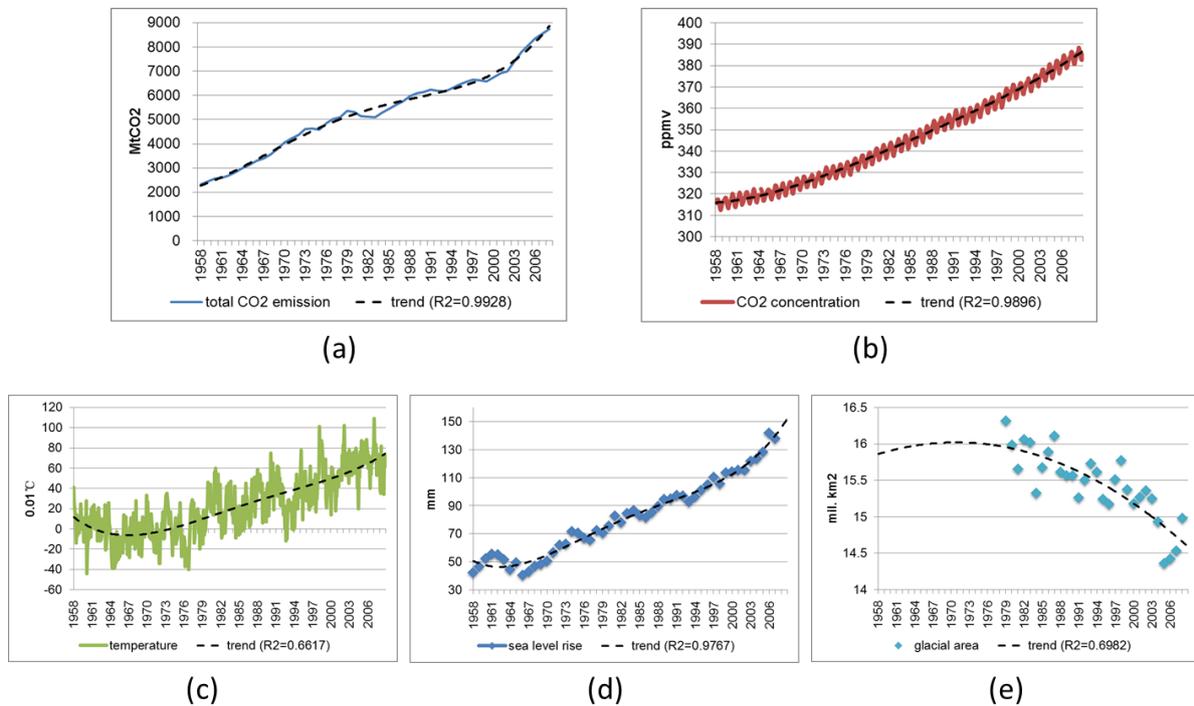


# Planning Delta City

## Where the global climate change meets the local urban development

### 1. Introduction

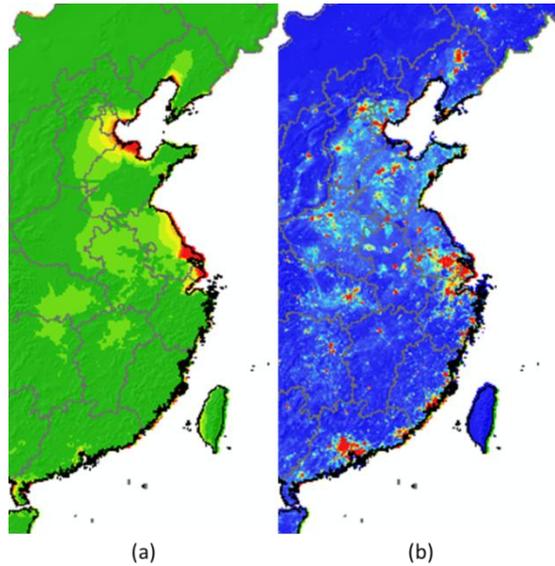
According to the IPCC AR4 [1] reports, the global climate change (GCC) largely influence the man-earth system by means of temperature and precipitation changing, sea level rising and extreme events increasing (Fig. 1). In China, the most economic-developed cities are spatially overlapped with the areas highly threatened by sea level rising and other GCC impacts (Fig. 2). The “Driver - Pressure - Status – Impact - Response” circle of GCC makes the delta cities becoming a local symbol of climate vulnerability, as well as the advance party of climate mitigation and adaption. The research area in this paper, Dongying Shandong at the Delta of the Yellow River, is also included.



Sources: CDIAC/DOE, NASA, PSMSL/NOC and NSIDC/NOAA

Fig. 1. Observations and trends of global climate change in last 50 years (a: global CO2 emission, b: global CO2 concentration, c: global average temperature, d: global average sea level rising, and e: global glacial area)

By learning lessons from other delta cities over the world, and reappraising the unique ecological value of Dongying, a comprehensive set of climate response measures are integrated into the latest master plan procedure of Dongying city.



Sources: USGS SRTM, RESDC/CAS

Fig. 2. (a) Locations of high sea level-rise threatened areas and (b) economic-developed cities in China, red colour indicates the highest value in both

## 2. Global cases learning

According to the researches, more than two thirds of the large mega urbanized regions are facing the impact of sea level rise. The future of millions of people will be exposed to extreme floods, hurricanes and other natural disasters as well as the threats of resource and environmental issues. Thus, some organizations like Connecting Delta Cities (CDC) [2] and C40 Cities (C40) [3] have started promoting and sharing innovative adaptation strategies, knowledge and best practices for climate action plan (Fig. 3).



Sources: CDC, C40

Fig. 3. Distributions of delta cities action cases over the world (1 Los Angeles, 2 Toronto, 3 New Orleans, 4 New York, 5 Buenos Aires, 6 London, 7 Madrid, 8 Rotterdam, 9 Copenhagen, 10 Lagos, 11 Ho Chi Minh City, 12 Hong Kong, 13 Shanghai, 14 Tokyo, 15 Jakarta, 16 Melbourne and 17 Dongying)

## 2.1 Rotterdam

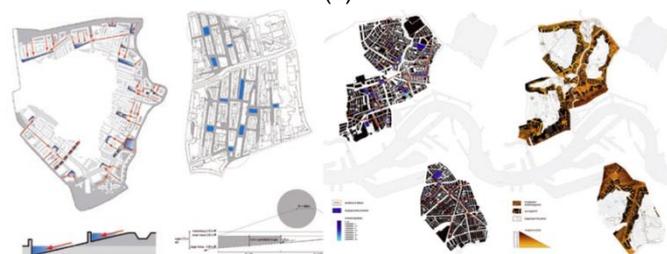
Along with the overall development objectives of Rotterdam: internationalized economy, flooding control and attracting population and employment, the major problems against climate change in future are flooding, water resources shortages and urban micro-climate deterioration.

By making the “Waterplan 2 Rotterdam” and “Rotterdam Climate Proof: 2009 Adaptation Programme” [4], Rotterdam promoted the "Climate Model City" strategies by reducing carbon emissions and improving the urban environment. To emphasize the water issues, Rotterdam improved urban planning and architectures through the flood control capacity and increasing attractiveness of the city, such as green roofs, swimming squares and a variety of innovative forms of water storage facilities. For sustainable use of water resources, water pollution prevention and control of extreme rainfall, rainwater storage and wastewater treatment system are newly updated. Major planning measures in the built-up area included:

- Urban centres: enhancing community liveable environment;
- Urban flood control planning: responding to sea level rise and land security;
- Urban water system cleaning: building rain and sewage diversion pipelines; sewage system automation management; controlling of urban runoff and non-point source pollution; improving the biodiversity of urban water systems;
- Water-town design: designing different water facilities for public based on the elevation of different parts in the city like "Water Plaza", closed water square, open-water network, urban levees and so on;
- Green roofs plan: reducing rainfall runoff and improving the urban microclimate and air quality, mitigating urban heat island effect and reducing noise as well as increasing species in urban areas.



(a)



(b)

Source: *Waterplan 2 Rotterdam*

Fig. 4. (a) Urban flooding plan and (b) “Water Plaza” and urban design strategies in Rotterdam

## 2.2 Hong Kong

As a well-known fast-growing and high density city, Hong Kong is also suffering from the global climate change and sea level rising issues. Besides, the insecurities on resources supporting and decreasing of bio-diversity also discourage the urban sustainability in Hong Kong.

The climate response strategies in Hong Kong constitute of three aspects, 1) greenhouse gas (GHG) emission reduction, 2) adaptation to climate change and 3) intensive urban plan. The GHG emission reduction focuses on promoting green building, public transportation, and clean energy generation like landfill gas, solar and wind-power, as well as improving the efficiency of urban energy systems. The climate change adaption plan emphasizes monitoring and conserving urban green systems and bio-diversity, enhancing flood resilience in built-up areas, evaluating supporting security of water resources and developing measures to deal with water shortages. The Intensive urban plan policy focuses on optimizing and restricting the urban pattern of development to ensure the ecological land use, promoting Transport-oriented supported by efficient public transportation with high coverage and high-capacity of rail network as well as slow traffic of walking and cycling in built-up districts, restoring abandoned industrial land and shifting to public or environmental use, and set-up urban greening plan like green space systems and green roofs.

In a summary, a consensus has been reached for delta cities and regions, connecting the climate action, water management and urban eco-environment enhancement more closely to a traditional formulating procedure of spatial and functional plan in urban plans. Strategies include:

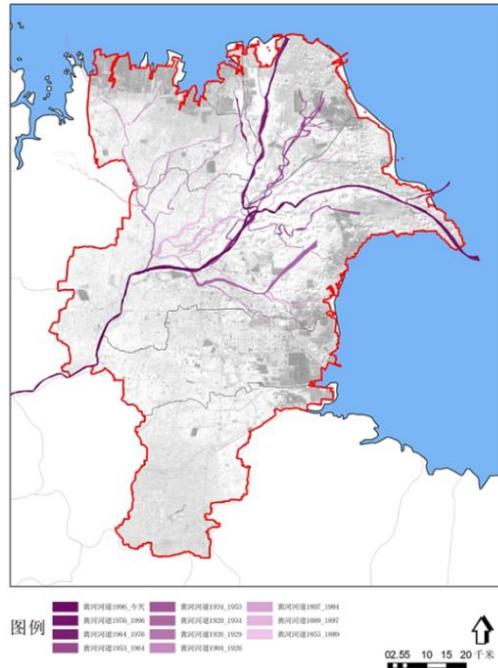
- **Function planning and construction of waterfront:** giving full consideration to land use planning impact of climate change risks; enhancing the multiple functions of urban water systems.
- **Building ecological network:** improving the urban ecological corridors and increasing the ecological value of sensitive land by effective spatial planning.
- **Coastal protection:** preventing losses of coastal wetlands led by land-use changes and erosion; using of engineering technologies like sand blowing and vegetation recovery.
- **Assessment on flooding and control facilities built:** reducing the risks of urban districts.
- **Management on water resources and storm water:** adapting to future water shortage caused by climate change; reducing the risk of waterlogging and improving the urban water environment.

## 3. Analysis and schemes of Dongying

As a major part of the Yellow River estuary, urban ecosystems of Dongying affected by regional climate changes over the years, as well as other changing environmental factors like the Yellow River runoff and its river-ways (Fig. 5), estuary land growth, wetland degradation,

land use pattern and urban environmental quality. As the youngest city and one of the oil gas production bases in China, the characteristics of “youth” and “change” are very important features of Dongying city.

By a comprehensive analysis of Dongying using SWOT framework, the advantages and inferiors for Dongying in the era of GCC are recognized. The spatial and action plan for Dongying was hereby composed by focusing on the integration of urban ecological value enhancement.



Source: data acquired from RESDC/CAS

Fig. 5. The changes of Yellow River ways over the past 200 years in Dongying

### 3.1 SWOT analysis of Dongying

#### 3.1.1 Strengths: land and ecological resources

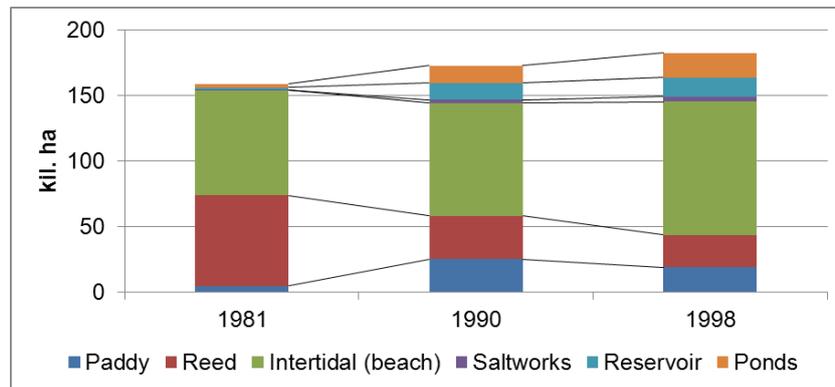
According to the historical records of Yellow River, the delta area in Dongying could be divided into the ancient, the modern and the contemporary parts. The speed of delta accretion was about 0.3 km per year before, creating a new land of 2500 ha every year. However, Since 1990s the delta accretion got slower for less water from the upper stream of Yellow River.

The National Nature Reserve of Yellow River Delta was established in the year of 1992. The 153,000 ha Reserve has become an important breeding place and transit area for the migrant birds. Some 6 million birds of 43 species travel through the area every year, which accounts for 1% of the total number of birds around the world according to statistics.

### 3.1.2 **Weakness:** wetlands and environment deteriorating

There are about 1,800 km<sup>2</sup> of wetlands in Dongying, accounting for 18% in the total area of the city. About 63% of the wetlands are perennial water wetlands (rivers, lakes, estuarine waters, ponds, reservoirs, salt pool, prawns-crabs pool and beach), the rest are seasonal water wetlands (tidal salt dampness, reed marshes, woodland swamps, shrub swamps, wet meadows, rice fields and other swamp). The activity of wetlands is mainly performance as fishing productivity. The Gross Primary Productivity (GPP) is higher at coastal and shallow marine areas for their favourable conditions. The richness and diversity of wetlands plays a great role in the regional ecosystem.

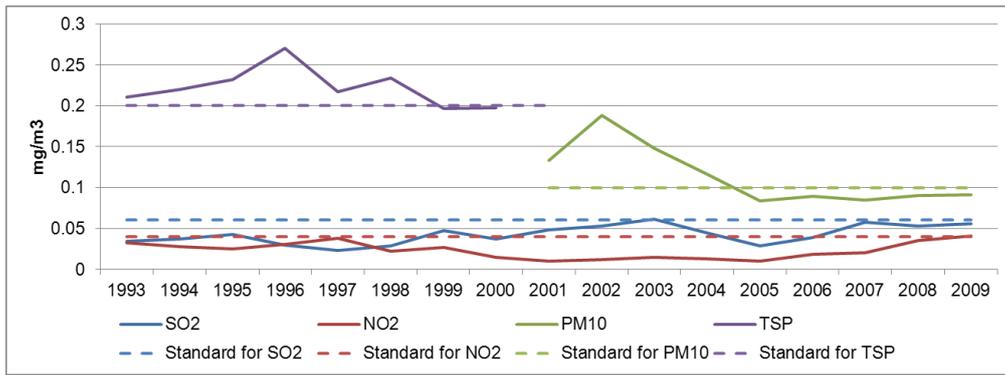
However, the dynamic growth and decline of wetlands are mainly driven by natural and human factors both. The total area of wetlands was increasing due to the delta accretion. Meanwhile the invasion of storm surges and tides as well as the human activities has made the proportion of salt area, reservoirs and ponds increasing. The area of reed with stronger ecological functions is shrinking (Fig. 6).



*Source: the author*

Fig. 6. Dynamic of structure of wetlands in Dongying

As a young industrial city located at the downstream of major rivers, the environment qualities like atmosphere and water are facing challenges. According to the monitoring data in last decades, after years of treatment facilities building and control, the emissions of air pollutants are declining, especially for the huge decreasing of PM<sub>10</sub> emissions. But the air qualities of SO<sub>2</sub> and NO<sub>2</sub> are reflecting signs of deterioration. Meanwhile the environmental capacities of water are exceeded overall due to the lack of pollutants control in the whole river basin.



Source: the author

Fig. 7. Dynamic of air quality indicators in Dongying

3.1.3 **Opportunities:** regional develop policies on ecological economy

Two of the recently released regional policies are great opportunities for the sustainable development of Dongying. One is the policy of “Efficient Ecological Economy in Yellow River Delta”, and another is the policy of “Shandong Peninsula Blue Economic Zone”. These policies coincided in Dongying, indicating the priority at higher decision-making level. Dongying could be benefited from several supporting policies as a transforming resources-based city, as an ecological compensation area and late-development city.

3.1.4 **Threats:** climate and land-use pattern changes

The coastline is vulnerable to the hits of tides and storm surges. The marine disaster prevention system like modern facilities, early warning and protection systems are lack, which makes the coastal protection systems in Dongying are not perfect. Due to the sea level rising issues caused by climate change, the vulnerability of Dongying and its highly sensitive areas like wetlands are increasing.

Meanwhile, according to the remote sensing image analysis, in the last 20 years, the land-use pattern has been changed significantly (Fig. 8). The built-up lands are largely increased except for the seashore area. Agriculture lands are also transformed from unused and grass lands notably. Saline and unused land increased along with the seawater invasion areas.



Source: the author

Fig. 8. Dynamic of land-use pattern in Dongying in last 20 years

Based on the IPCC and Chinese research papers on the relationship of land-use types, changes and carbon emissions, the carbon sinking capabilities of different land-use types play major roles in the global climate change but are various. Generally, the sinking capability of wetlands is much higher than other terrestrial ecosystems like forest, grass and agricultural land. The transformation from wetlands to other land-use or increasing of human built-up area is consequently leading to GHG emissions.

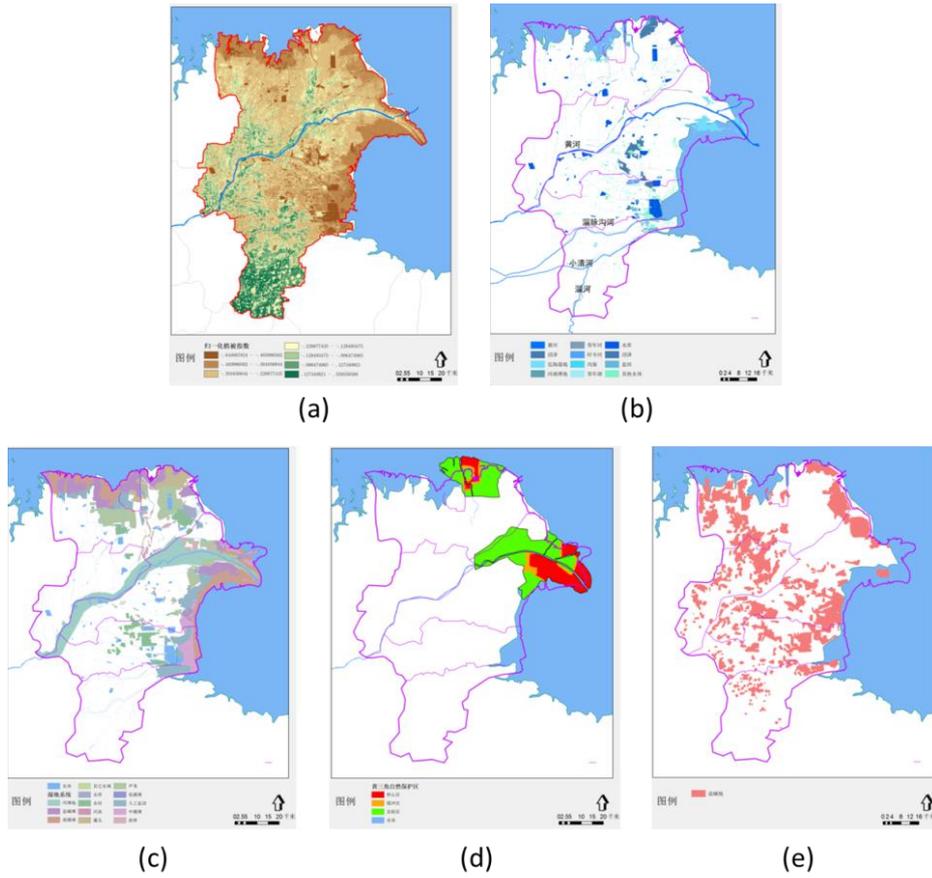
### **3.2 Spatial and action plan for Dongying**

#### **3.2.1 Principles**

According to the analysis above, as a climate vulnerable delta area, the protection and restoration of land with higher ecological values like wetland and forest in Dongying is requested by climate action and ecological security both. The aims for making local places better and mitigating global issues have made an agreement in this plan project.

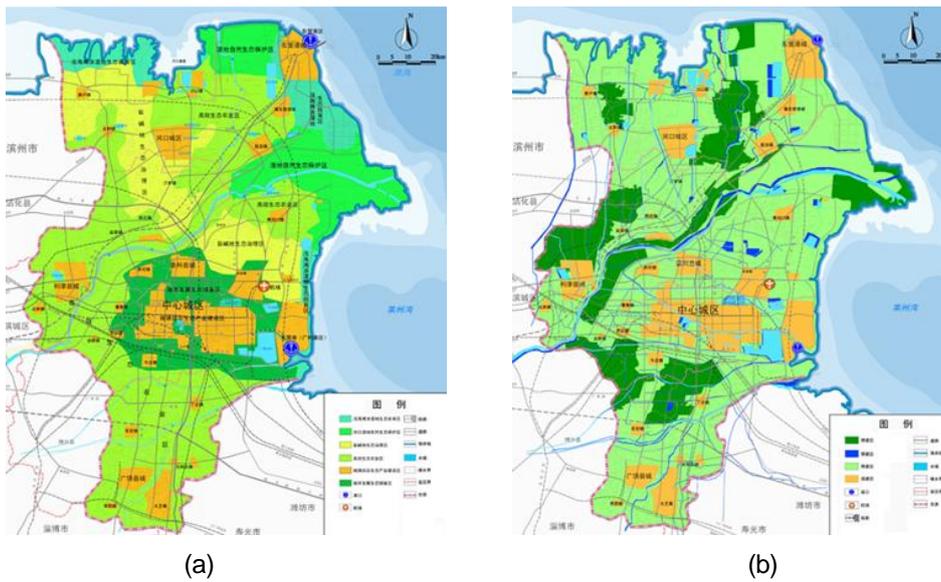
#### **3.2.2 Strategies and schemes**

- **Identifying key elements in the ecological security patterns** (Fig. 9): vegetation-rich areas, water networks and wetland areas, nature reserves and ecological restoration area.
- **Ecological functions zoning** (Fig. 10 a): Shallow beach ecological zone, Wetland conservation zone, Grassland fencing zone, Urban eco-environmental enhancing zone, Petroleum and mining afforestation zone, Saline ecological improving zone and eco-agricultural zone.
- **Spatial regulations on development** (Fig. 10 b): forbidden building area, conditional building area and suitable building area.



Sources: the author

Fig. 9. Identification of key ecological security elements (a: vegetation richness, b: water systems, c: wetlands, d: natural reserve, and e: ecological restoration - saline land)



Sources: the author

Fig. 10. Spatial schemes on Dongying urban ecosystem (a: Ecological functions zoning, b: Spatial regulations on development)

### 3.2.3 Measures

To improve the coastal protection system, including dykes and gates construction, preventing the ocean disasters; dredging the major river to ensure a better capability of flooding resilience; controlling the Blue line of the river networks, especially in the built-up and agricultural areas;

To increase forest with selected trees, enhancing the vegetation richness and bio-diversities for building up an active ecosystem and natural shelter for urban area;

To determine the nature reserves, heritage, water resources, and infrastructure installations in accordance with strict regulations. Strengthen wetland nature reserve management, setting up marine protected areas and governing fisheries ecology.

### 4. Comments

This project explored the possibility to connecting the global and local requirements of sustainability, by emphasizing the unique land with higher value to each scale, as well as set up zoning and regulations for urban development in future.

During the planning, the author felt a lack of methodology of indicators and standards which can evaluate (quantitatively) the whole circle, from drivers and impacts of climate changes, to the mitigation and adaption response of local communities, especially the effects of response to the impacts. Further physical-based modelling and researches on the climate change and local urban ecosystems are expected.

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### References

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- [1] IPCC (2007) *Climate Change 2007: Synthesis Report*
  - [2] Connecting Delta Cities (CDC), [http://www.rotterdamclimateinitiative.nl/nl/delta\\_cities\\_website](http://www.rotterdamclimateinitiative.nl/nl/delta_cities_website)
  - [3] C40 Cities, <http://www.c40cities.org>
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