Gwangju’s GHG Reduction Initiatives and Urban Climate and Environmental Assessment Model

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Need and Objective for GHG Reduction
Need and Objective for GHG Reduction

Need

- The South Korean government has set a goal under the Paris Agreement to reduce emissions by 815 mil tons by 2030
- **Local governments need to develop an emissions reduction roadmap** to meet the reduction targets in the non-industrial sectors* (96 mil tons), which are to be managed under the authority of local governments
  
  *Non-industrial sectors: e.g. residential, commercial, public, transport, agro-livestock, waste
  - To be managed under the authority of local governments (hence the use of reduction inventory - TBD)
  - 72% of local governments’ reduction plans focus on non-industrial sectors
  - More likely to reduce emissions than the industrial sector → Resistance to change in the industrial sector
  - GHG reduction initiatives tend to see immediate results (direct reduction projects)
  - Limitation: Accurate monitoring and management can be challenging, given that reduction projects entail multiple sectors and areas

- **Gwangju has drafted a 2030 GHG emissions reduction roadmap to contribute to national reduction goals and streamline the city’s existing climate change plans**
Objective and scope

2030 Gwangju GHG emissions reduction roadmap

1. Status and prospects of Gwangju’s GHG emissions
   - Set out directions for climate energy policy

2. Estimated emissions and reduction targets in 2030
   - Contribute to national reduction goals

3. Action plans to meet 2030 GHG reduction goals

- Spatial scope: City-wide
- Temporal scope: Base year 2005, target year 2030
- Emissions: Down 30.3% from Gwangju’s BAU levels in 2030 ※ Allocated by Ministry of Environment
- Emission sources: Scope1 (direct sources), Scope2 (indirect sources)
GHG Emissions: Status and Prospects
Total GHG emissions in Gwangju: Total inventory

- Emissions in 2015 (direct and indirect combined):
  - 5,665,000 tons (direct) + 4,175,000 tons (indirect) = 9,840,000 tons
  - 8,092,000 tons in 2005 → 9,840,000 tons in 2015 (up 22%)

Direct emissions: Emissions directly resulting from fuel combustion or product manufacturing within the boundaries of a local government area

Indirect emissions: Emissions from consumption of electricity or heat
Gwangju’s GHG emissions: Reduction inventory

Total emissions: 5,710,000 tons in 2005 → 6,949,000 tons in 2015 (up 22%)

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</thead>
<tbody>
<tr>
<td>Residential</td>
<td>1,573</td>
<td>1,759</td>
<td>1,745</td>
<td>1,779</td>
<td>1,947</td>
<td>1,940</td>
<td>1,708</td>
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<tr>
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<td>1,831</td>
<td>1,808</td>
<td>1,852</td>
<td>1,862</td>
<td>1,772</td>
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<tr>
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<td>3,590</td>
<td>3,552</td>
<td>3,631</td>
<td>3,809</td>
<td>3,711</td>
<td>3,535</td>
<td>51%</td>
</tr>
<tr>
<td>Public/others</td>
<td>236</td>
<td>279</td>
<td>271</td>
<td>280</td>
<td>301</td>
<td>290</td>
<td>266</td>
<td>4%</td>
</tr>
<tr>
<td>Transport (roads)</td>
<td>1,884</td>
<td>2,189</td>
<td>2,229</td>
<td>2,422</td>
<td>2,583</td>
<td>2,696</td>
<td>2,824</td>
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<tr>
<td>Agro-livestock</td>
<td>80</td>
<td>64</td>
<td>65</td>
<td>59</td>
<td>59</td>
<td>59</td>
<td>60</td>
<td>1%</td>
</tr>
<tr>
<td>Waste</td>
<td>297</td>
<td>276</td>
<td>259</td>
<td>267</td>
<td>278</td>
<td>267</td>
<td>263</td>
<td>4%</td>
</tr>
<tr>
<td>Total</td>
<td>5,710</td>
<td>6,399</td>
<td>6,376</td>
<td>6,660</td>
<td>7,030</td>
<td>7,024</td>
<td>6,949</td>
<td>100%</td>
</tr>
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</table>

(Unit: 1,000 tons)

※ System that enables the management of reduction projects in the managed areas

Total emissions: 5,710,000 tons in 2005 → 6,949,000 tons in 2015 (up 22%)
Total inventory vs. Reduction inventory

On average, reduction inventory is 71% of total inventory; remaining 29% are emissions outside the authority of Gwangju.
Gwangju’s estimated total emissions in 2030 (BAU)

- Overall CAGR between 2015 to 3000: 0.32%
- Up 0.03% in 2025 and 0.05% in 2030 from 2015 levels
- Continued increase in transport and buildings
- Gradual decrease in waste and agro-livestock

CAGR by sector (2015-2030)

<table>
<thead>
<tr>
<th>Sector</th>
<th>CAGR</th>
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<tbody>
<tr>
<td>Residential</td>
<td>1.12%</td>
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<tr>
<td>Commercial</td>
<td>2.07%</td>
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<tr>
<td>Public/others</td>
<td>0.38%</td>
</tr>
<tr>
<td>Transport (roads)</td>
<td>0.61%</td>
</tr>
<tr>
<td>Agro-livestock</td>
<td>-2.34%</td>
</tr>
<tr>
<td>Waste</td>
<td>-4.94%</td>
</tr>
</tbody>
</table>

GHG Emissions: Status and Prospects
Setting GHG Emission Reduction Targets
Setting GHG Emission Reduction Targets

- **Types of emission cuts**
  - **Managed cuts:** Emission cuts that can be managed/controlled by a local government’s GHG reduction projects
    - e.g. Solar PV generation, wider adoption of EVs, energy saving in buildings, urban forests
    - Emissions can be monitored, which allows for planned reduction
  - **Non-managed cuts:** Emission cuts that cannot be managed/controlled by GHG reduction projects
    - e.g. Population decline, recession, uptake of new technology, strengthened efficiency, eco-friendly buildings, improvement of existing facilities
    - Emissions cannot be monitored as they occur from random and multiple sources/projects; planned reduction is impossible

<table>
<thead>
<tr>
<th>Total emissions to be reduced (1,000 tons)</th>
<th>Managed cuts (1,000 tons)</th>
<th>Non-managed cuts (1,000 tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,472</td>
<td>1,674</td>
<td>798</td>
</tr>
</tbody>
</table>

Gwangju needs to cut down 1,674,000 tons CO$_2$eq. by 2030
### Setting GHG Emission Reduction Targets

**Gwangju’s target emission cuts by 2030 based on reduction potentials**

<table>
<thead>
<tr>
<th>Criteria</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
<th>2023</th>
<th>2024</th>
<th>2025</th>
<th>2026</th>
<th>2027</th>
<th>2028</th>
<th>2029</th>
<th>2030</th>
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<tr>
<td>2030 BAU</td>
<td>7,253</td>
<td>7,344</td>
<td>7,427</td>
<td>7,512</td>
<td>7,587</td>
<td>7,672</td>
<td>7,756</td>
<td>7,839</td>
<td>7,921</td>
<td>7,993</td>
<td>8,073</td>
<td>8,153</td>
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<tr>
<td>Residential</td>
<td>222</td>
<td>281</td>
<td>317</td>
<td>354</td>
<td>390</td>
<td>425</td>
<td>460</td>
<td>494</td>
<td>528</td>
<td>562</td>
<td>596</td>
<td>629</td>
</tr>
<tr>
<td>Commercial</td>
<td>302</td>
<td>373</td>
<td>418</td>
<td>465</td>
<td>513</td>
<td>562</td>
<td>612</td>
<td>660</td>
<td>709</td>
<td>759</td>
<td>810</td>
<td>861</td>
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<tr>
<td>Public/others</td>
<td>30</td>
<td>39</td>
<td>42</td>
<td>46</td>
<td>49</td>
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<td>57</td>
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<td>63</td>
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<tr>
<td>Transport (roads)</td>
<td>183</td>
<td>224</td>
<td>274</td>
<td>327</td>
<td>382</td>
<td>443</td>
<td>507</td>
<td>576</td>
<td>649</td>
<td>724</td>
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<tr>
<td>Agro-livestock</td>
<td>1</td>
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<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
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<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Waste</td>
<td>25</td>
<td>29</td>
<td>32</td>
<td>36</td>
<td>40</td>
<td>44</td>
<td>48</td>
<td>52</td>
<td>55</td>
<td>59</td>
<td>63</td>
<td>66</td>
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<tr>
<td>Subtotal</td>
<td>763</td>
<td>947</td>
<td>1,085</td>
<td>1,230</td>
<td>1,377</td>
<td>1,529</td>
<td>1,685</td>
<td>1,844</td>
<td>2,008</td>
<td>2,174</td>
<td>2,320</td>
<td>2,472</td>
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<tr>
<td>Managed</td>
<td>249</td>
<td>682</td>
<td>767</td>
<td>858</td>
<td>952</td>
<td>1,050</td>
<td>1,153</td>
<td>1,259</td>
<td>1,369</td>
<td>1,482</td>
<td>1,575</td>
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<td>Project-based cuts</td>
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<tr>
<td>Cuts</td>
<td>211</td>
<td>425</td>
<td>479</td>
<td>532</td>
<td>586</td>
<td>639</td>
<td>692</td>
<td>745</td>
<td>798</td>
<td>692</td>
<td>745</td>
<td>798</td>
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<tr>
<td>Non-managed</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Total emission cuts</td>
<td>763</td>
<td>947</td>
<td>1,085</td>
<td>1,230</td>
<td>1,377</td>
<td>1,529</td>
<td>1,685</td>
<td>1,844</td>
<td>2,008</td>
<td>2,174</td>
<td>2,320</td>
<td>2,472</td>
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</tbody>
</table>
Setting GHG Emission Reduction Targets

- Ways to set reduction targets and possible reduction scenarios
  - Ensure the targets are based on Gwangju’s current emission trends and are achievable
  - Reduce administrative and budget burdens by building on existing projects, where possible → Target proposal to be based on proposed reduction measures and actionable means
  - “Managed, project-based reduction potentials + Non-managed reduction potentials = total cuts”
    ※ This doesn’t involve management of non-managed cuts
  - Consider non-managed cuts
    e.g. Encourage participation through education, promotion and awareness-raising campaigns in managed indirect emissions projects
  - This is because the authority to control non-managed cuts is undefined, even if the cuts are from within Gwangju
  - Unlike managed cuts, it is impossible to monitor non-managed cuts; a local government can only adjust emissions through GHG reduction projects

Identify reduction scenarios by 2030 based on existing projects

Can the targets be met with the existing projects?

- Yes
  - Can the projects be executed immediately?
  - Are there any obstacles?
  - Start new projects or expand existing ones → To draft additional scenarios
  - Can the budget be secured?

- No
  - Revisit the entire reduction projects
  - Expand the existing projects
  - Expand new projects
  - Find ways to secure project budget
2 suggested scenarios for emissions reduction

**Scenario 1 (S_1)**
- Review Gwangju’s existing climate projects
- Make conservative estimates of the projects’ growth rates from 2011 to 2016
- Minimize administrative burden
- Note the improvement required to meet the reduction targets
- Ensure that the selected reduction projects are effective

**Scenario 2 (S_2)**
- Expand the selected existing projects in Scenario 1 and add new projects to increase reductions
- If Scenario 1 fails to meet the reduction targets, propose guidelines on additional projects
- A mix of expanded existing projects and new projects
  - Expanded existing projects: Effectiveness, feasibility
  - New projects: Effectiveness, feasibility
Setting GHG Emission Reduction Targets

- **Overall reduction targets**

If reduction targets are met, GHG emissions in 2030 will be 82% of 2005 levels.
If Scenario 2 reduction targets are met, GHG emissions in 2030 will be 53% of 2005 levels.
Reduction Targets, Action Plans and Evaluation
Vision, Goal and Strategies

2030 Gwangju GHG emissions reduction roadmap

Vision
Gwangju, a green city and a leader in low-carbon urban growth

Goal
To cut down GHG emissions by 30.3% from BAU levels in 2030

Guiding principles
- Public sector-led GHG reduction efforts involving citizen participation
- Toward a low-carbon city where the economy thrives and jobs are created
- Inclusive reduction initiatives that first cater for the vulnerable
- Groundwork for a transition to low-carbon urban living

Core strategies
- Environment
  Green space
  Expand green space that lowers temperatures in the city and protects from fine dust to increase carbon absorption
- Economy
  New energy industries
  Foster and develop new energy industries to create jobs and reduce GHG emissions
- Society
  Low-carbon culture
  Lay the groundwork for a low-carbon, green-living culture based on citizen and community involvement

Implement ation strategies
- Leading and effective GHG reduction policy in the public sector
- Initiatives linked to the city’s sectoral plans and policy that deliver tangible results
- New initiatives based on Fourth Industrial Revolution technologies and new energy industries
- Everyday GHG reduction campaigns that ensure citizen and community involvement
### Action Plans by Sector

- **Sectoral action plans:** 61 projects in total (under Scenario 2)

<table>
<thead>
<tr>
<th>Sector</th>
<th>Scenario 1</th>
<th>Scenario 2 (Strengthened reductions)</th>
<th>Action plans</th>
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<tbody>
<tr>
<td></td>
<td>Target cuts (1,000 tons)</td>
<td>Share (%)</td>
<td>Target cuts (1,000 tons)</td>
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<td><strong>Buildings</strong></td>
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<tr>
<td><strong>Renewables</strong></td>
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<td>576</td>
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<tr>
<td><strong>Transport</strong></td>
<td>265</td>
<td>30</td>
<td>741</td>
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<tr>
<td><strong>Waste</strong></td>
<td>138</td>
<td>15</td>
<td>146</td>
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<td></td>
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<tr>
<td><strong>Agro-livestock</strong></td>
<td>0.55</td>
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<td>109</td>
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<td><strong>Land use</strong></td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>890</strong></td>
<td><strong>100</strong></td>
<td><strong>2,876</strong></td>
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</table>
Action Plans by Sector

- **Buildings**

  **Carbon points program**
  - Project description
    - Voluntary, citizen-led energy-saving efforts rewarded with incentives
  - Project scope and budget (for 2030)
    - Combined (electricity, city gas, water) / 80 bil won (state funding 39 bil, city funding 41 bil)
  - Estimated emissions cuts: 97,000 tons

  **NOx reduction equipment**
  - Project description
    - NOx reduction equipment installed at SMEs to reduce GHG emissions and fine dust
  - Project scope and budget (emissions cuts for 2030/ budget for 2018)
    - 878 units/ 526 mil won (state funding 376 mil, city funding 150 mil)
  - Estimated emissions cuts: 232,000 tons
Buildings

- **Project description**
  - Energy management system introduced to new buildings to cut down GHG emissions (required by law)
- **Project scope and budget** (for 2030)
  - 2,427,194m² / Existing policy measure; no budget needed
- **Estimated emissions cuts**: 316,000 tons (accumulated)

Performance improvements in new public buildings

- **Project description**
  - Mandatory building energy efficiency standards from 2030 for public buildings
- **Project scope and budget** (emissions cuts for 2030/budget for 2018)
  - 2,917,230m² / Existing policy measure; no budget needed
- **Estimated emissions cuts**: 269,000 tons (accumulated)
Action Plans by Sector

Renewables

- **Project description**
  - Electricity generated from combined heat and power plants is supplied to a local community to save energy and reduce GHG emissions
- **Project scope and budget** (for 2030)
  - 21,587,500㎡ / Facilities already installed; maintenance project
- **Estimated emissions cuts**: 48,000 tons

Subsidies for homes with renewable technology

- **Project description**
  - Solar PV, solar heat, geothermal or fuel cell installations in homes are entitled to subsidies.
- **Project scope and budget** (emissions cuts for 2030)
  - 674kW (solar PV) / 320 mil won (for 2018)
- **Estimated emissions cuts**: 286,000 tons (accumulated)
### Renewables

- **Project description**
  - Solar PV panels installed on the roofs of 20 elementary/middle/high schools per year

- **Project scope and budget (for 2030)**
  - 2,000kW per year / 3 bil won (private funding)

- **Estimated emissions cuts**: 82,000 tons (accumulated)

### Agricultural solar sharing

- **Project description**
  - Solar PV panels installed on farmland to contribute to reducing GHG emissions and help farmers earn additional income

- **Project scope and budget (emissions cuts for 2030)**
  - 674kW (solar PV) / 4 bil won (private funding)

- **Estimated emissions cuts**: 69,000 tons (accumulated)
Transport

- **Project description**
  - Deployment of EVs in the city to reduce GHG emissions and fine dust
- **Project scope and budget (for 2030)**
  - 248,000 units (accumulated) / 28.5 bil won (for 2019)
- **Estimated emissions cuts**: 248,000 tons (accumulated)

LCV and ZEV uptake

- **Project description**
  - Deployment of low emission FCEVs to reduce GHG emissions and fine dust
- **Project scope and budget (emissions cuts for 2030)**
  - 674kW (solar PV) / 23.9 bil won (state funding 11.6 bil, city funding 12.4 bil)
- **Estimated emissions cuts**: 107,000 tons (accumulated)
Transport

- Project description
  - City’s transport network centering on public transport to reduce GHG emissions and fine dust
- Project scope and budget (for 2030)
  - 45,000 out of 459,000 units / 6 bil won (total budget)
- Estimated emissions cuts: 115,000 tons

- Once a week no driving day campaign
  - Project description
    - A weekly no driving day program to boost public transport use and reduce GHG emissions and fine dust
  - Project scope and budget (emissions cuts for 2030)
    - 68,000 out of 459,000 units / no budget needed
  - Estimated emissions cuts: 18,000 tons
Waste

- Project description
  - RFID-based volume-based waste fee system; GHG emissions reduced across all stages from waste collection to treatment
- Project scope and budget (for 2030)
  - 340,000 households / 5 bil won (accumulated budget)
- Estimated emissions cuts: 7,000 tons

Biogas production using food waste leachate

- Project description
  - Food waste leachate treated to produce biogas energy, contributing to GHG emissions reduction
- Project scope and budget (emissions cuts for 2030)
  - 2,477 tons / Facilities already installed; only maintenance costs will incur
- Estimated emissions cuts: 52,000 tons
Agro-livestock

- **Project description**
  - Support for energy-saving and efficiency farming facilities to reduce GHG emissions

- **Project scope and budget (for 2030)**
  - 6ha / 600 mill won (per year)

- **Estimated emissions cuts:** 500 tons

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Biogas plant trial project

- **Project description**
  - Trial project to create a zero-waste village by turning agricultural waste to energy

- **Project scope and budget (emissions cuts for 2030)**
  - 20 tons / 10 bil won (state funding)

- **Estimated emissions cuts:** 93,000 tons
Land use

Urban forests: creation and maintenance

- Project description
  - Create urban forests and expand forest resources for climate change adaptation and fine dust mitigation

- Project scope and budget (for 2030)
  - 6,239 ha / 12.5 bil won (for 2018)

- Estimated emissions cuts: 65,000 tons

3D greenery in Gwangju

- Project description
  - Mitigate heat waves and fine dust and create a pleasant urban environment

- Project scope and budget (emissions cuts for 2030)
  - 2.25 mil m² / 30 bil won (until 2027)

- Estimated emissions cuts: 3,700 tons
Monitoring and Evaluation

Evaluation of GHG emissions reduction roadmap

Set reduction target for each project

Check progress of projects

Check emission reductions from projects

Indicator-based evaluation

Quantitative evaluation

Estimate total emission reductions (②) and analyze results

Compile evaluation results

Target not met

Target met

Task Force

Develop/verify reduction inventory

Analyze whether target levels are met

Evaluate whether target (allowed) emission levels are met

Causal analysis

Final target (allowed) emission levels met

Final target (allowed) emission levels not met

ICEC

Estimate actual emissions (Include offsets such as renewables)

[Qualitative evaluation]

Target met (allowed levels ≥ actual emissions)

Target not met (allowed levels < actual emissions)

Council

Report and publish emission reductions

Incorporate the shortfall against target

Identify new projects

Check emission reductions from projects

Evaluate whether target levels are met

Causality analysis

Estimate actual emissions (Include offsets such as renewables)

Final target (allowed) emission levels met

Final target (allowed) emission levels not met
Urban Climate and Environmental Assessment Model
Urban Climate and Environmental Assessment Model

- **Background for model development**

  **New urban environment issue arises**

  **Heat waves/urban heat island**
  - Summer heat waves caused by global warming
  - Health concerns for the vulnerable
  - Growing use of AC
  - Environmental issues and global warming

  **Fine dust**
  - Use of fossil fuels creates fine dust
  - Fine dust blown from outside increases concentration
  - Fine dust stays longer in the area
  - Health concerns for the vulnerable

- **Frequent extreme weather conditions due to climate change**
  - **Heightened climate variability** caused by global warming
    - Increase in frequency and intensity of abnormal weather events
  - **Extreme weather events** have become routine
    - e.g. heat waves, cold spells, heavy rain, droughts
  - Rise in tropical nights, heat-related illnesses and deaths
  - Repeated incidents of urban flooding
  - **Fine dust** pollution from use of fossil fuels
    - Fine dust stays longer in the city

- **Changes caused by urbanization**
  - Over 90% of total population **lives in cities due to urbanization**
    - Ratio of population living in cities **91%**
    - 90% of world population projected to live in urban areas by 2050
  - Population density rises and the **city’s structure becomes more complex**
  - Increase in population density and industrial/economic infrastructure density
    - More massive, irregular and complicated damage
  - Man-made structures cause environmental issues
  - Management of **sustainable energy** supply and demand necessary

**Need for objective and scientific information about heat waves/fine dust**
Objectives of model development

1. Build an integrated database on heat waves and fine dust and use it as a decision making tool to assist administrative action.
2. Develop policies based on research and promote the growth of relevant industries.
3. Provide a wealth of information to improve the health of citizens and strengthen their climate response.
4. Strengthen the climate response of cities worldwide through the UEA’s Knowledge Sharing Programs.

Improve the quality of living for citizens and enhance the city’s standing by addressing local climate events such as heat waves and fine dust.
Urban Climate and Environmental Assessment Model

- Model structure and how it works

- NMHSs
- GPC
- Institutes
- Obs.

- Seasonal prediction system
- Urban assessment system
- Database
- UEA expert training program
- Research & Application Communities
- Capacity Building & Development
- UEA Member Cities
- Decision makers

- User
Urban Climate and Environmental Assessment Model

- **Characteristics**

  - Model builds on the existing meteorological service to enable city-specific service based on the city’s microclimate

```
National meteorological service  
(Spatial resolution 3km × 3km)  

Urban Climate and Environmental Assessment Model  
(Spatial resolution 0.01km ~ 0.1km)
```

- Vulnerable to climate risk

- Effective response to climate risk

- Creates a safe city by helping develop effective response to risk
Characteristics

Urban Climate and Environmental Assessment Model
Characteristics

Analysis of wind trajectories in the city to analyze, evaluate and predict the wind path.

Analysis of the city’s overall heat environment; spatial analysis, evaluation and prediction of areas vulnerable to heat.

Analysis and evaluation of heat and wind environments.

Analysis of wind trajectories in the city to analyze, evaluate and predict the wind path.

Analysis of the city’s overall heat environment; spatial analysis, evaluation and prediction of areas vulnerable to heat.

Analysis and evaluation of heat and wind environments.
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