Brainhack - SpaceCube 2025 Image Processing Challenge

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| Team Name: |  |

Congratulations on finding the mission target. This is the final segment of the Brainhack – SpaceCube2025 challenge. Process the given Landsat-8 images and share your team’s findings in the format below. Email your answers to [wheee@nus.edu.sg](mailto:wheee@nus.edu.sg) before **12th June 2025, 1255 Hrs**.

1) Insert composite images used in the analysis here. Be sure to caption them.

2) Identify as many features as possible. You may annotate them in the images and attach screenshots here.

3) Reflection. How do you think the use of multispectral composite images from space can solve challenges faced by Singapore?

**Using Multispectral Satellite Imagery to Address Singapore’s Urban and Environmental Challenges**

Singapore is a highly urbanised city-state with limited land, dense infrastructure, and a pressing need to balance development with sustainability. As the nation faces growing challenges from urban heat, climate change, water scarcity, and environmental degradation, advanced remote sensing tools have become increasingly important. Among these, **multispectral satellite imagery** offers a powerful means of consistently monitoring land, water, and air conditions over time. By leveraging different spectral bands, composite images can reveal patterns and changes that are invisible to the human eye, providing valuable data for policy-makers, planners, and environmental scientists.

One of the most critical issues Singapore faces is the **Urban Heat Island (UHI)** effect. As concrete and asphalt surfaces dominate the cityscape, heat retention leads to elevated temperatures, particularly at night. To mitigate this, Singapore has set ambitious goals to increase urban greenery through initiatives like green roofs, vertical gardens, and nature corridors. Multispectral satellite imagery, especially in the **infrared spectrum**, enables the generation of composite images that measure **thermal radiation** across the city. These images can be used to monitor changes in surface temperature consistently over time, allowing authorities to assess the effectiveness of greening strategies and refine urban design for better climate responsiveness.

In addition to thermal monitoring, multispectral imagery is essential for managing **Singapore’s water resources**. With limited freshwater sources, the nation relies heavily on reservoirs, desalination, and imported water. Satellite indices such as the **Normalized Difference Water Index (NDWI)** and **Modified NDWI (MNDWI)** are particularly effective for detecting and monitoring **open water bodies**. These indices can track reservoir levels, detect **sedimentation** or **algal blooms**, and even reveal **unauthorised land use** near water catchment areas. Furthermore, the use of coastal and aerosol bands enhances **maritime monitoring** and supports the detection of **coastal erosion**, which is especially important given Singapore’s low-lying coastal zones.

Another area where multispectral imagery proves invaluable is in **disaster preparedness and climate resilience**. As a coastal city vulnerable to **flooding**, **sea-level rise**, and **intense rainfall events**, Singapore must continually assess its exposure to natural hazards. By analysing **time-series composites**, authorities can monitor **flood-prone areas**, track **coastal changes**, and evaluate the progression of **erosion** along shorelines. When combined with **elevation data**, these insights can be used to develop detailed **flood risk maps**, informing infrastructure planning and emergency response strategies.

Air quality is another key environmental concern, especially due to **transboundary haze** from regional forest fires and local sources of pollution. **Coastal aerosol and blue bands** (Bands 1 and 2) in multispectral datasets are useful for detecting **haze layers**, **atmospheric scattering**, and **cloud cover**, enabling clearer analysis of land and vegetation. These inputs can supplement ground-based data collected by the National Environment Agency (NEA), improving the spatial resolution and context of air quality models used for public health advisories and mitigation efforts.

Beyond environmental monitoring, multispectral composite images are also a critical tool for **urban planning and land use management**. With ongoing development and the need for land optimisation, authorities must carefully balance **urban expansion** with **nature conservation**. Satellite imagery enables the **classification of land cover types**, helping planners track changes in vegetation, monitor deforestation, and detect new developments. These insights support **Smart Nation initiatives** and guide sustainable infrastructure growth by providing an accurate, up-to-date view of land use dynamics.

In conclusion, multispectral satellite imagery offers a multifaceted solution to many of Singapore’s most pressing challenges. By capturing data beyond the visible spectrum, it allows for in-depth analysis of urban temperature, vegetation health, water resource availability, coastal vulnerability, air quality, and land use change. As Singapore continues to develop within its spatial and environmental constraints, the integration of satellite-based monitoring into policy-making and planning processes will be essential for achieving long-term resilience, sustainability, and livability.