ASSESSMENT OF LAND USE AND LAND COVER CHANGES IN MORSHI TALUK, AMRAVATI DISTRICT, MAHARASHTRA USING REMOTE SENSING DATA AND GIS TECHNIQUES

Abstract

The rapid growth of the population and human activities on Earth is significantly altering the natural environment. Consequently, this paper endeavours to assess and delineate changes in Land Use/Land Cover (LULC) in Morshi Taluk, Amravati District. Employing a Remote Sensing (RS) and GIS approach, Landsat imagery from 2014 and 2022 was utilized, The LULC maps for these years were generated through supervised classification, employing both the maximum likelihood algorithm and a multi-sectoral supervised classification algorithm tailored to Landsat sensor data. The Extract by Mask tool was employed to isolate the desired location, followed by the application of image classification tools using various band combinations, such as false-colour composite (5,4,3). The classification scheme for land use/land cover was executed based on Landsat 8 TM satellite images. The research reveals significant changes in Crop land, built-up areas (including urban areas, roads, and settlements), water bodies, and waste lands. In 2014, the built-up area constituted 1.67% of the total land, experiencing an increase of approximately 0.7% by 2022. Over the decade, the agricultural (crop land) area decreased by 2.98%, while waste land, representing 4.96% of the total area in 2014, increased by nearly 0.34% by 2022. The water body, constituting 3.94% of the total area, increased by almost 1.94% over the same period. The quantification of LULC changes in the Morshi area provides valuable information for environmental management, aiding informed decision-making and enhancing understanding of the surrounding environment

.**Keywords:** Land use-Land cover, supervised classification, RS &GIS, Morshi

Introduction

The spatial arrangement of land use and land cover within a region results from a combination of natural and socio-economic factors, shaped by human activities across time and space. With escalating agricultural and demographic pressures, land is increasingly becoming a limited resource. Therefore, having comprehensive information on land use/land cover and exploring optimal utilization possibilities is crucial for formulating and executing effective land use schemes. This is essential to address the growing demands for basic human needs and welfare. Additionally, this information aids in monitoring the evolving dynamics of land use in response to the changing demands of a growing population. The transformation of land use and land cover has become a pivotal aspect of contemporary strategies for natural resource management and environmental change monitoring. Advances in vegetation mapping have significantly contributed to research on land use/land cover changes, enabling a precise assessment of the distribution and health of global forests, grasslands, and agricultural resources. The ability to observe Earth from space has become indispensable for comprehending the impact of human activities on the natural resource base over time. In scenarios characterized by rapid and often undocumented land use changes, Earth observations from space offer objective insights into human utilization of the landscape. In recent years, data from Earth sensing satellites have played a vital role in mapping Earth's features and infrastructures, managing natural resources, and studying environmental changes. Furthermore, satellite remote sensing data have proven effective in estimating Leaf Area Index (LAI) by leveraging the relationship between LAI and the Normalized Difference Vegetation Index (NDVI) (Jaiswal et al., 1999). The integration of remote sensing technology with Geographic Information System (GIS) aids in extracting a wealth of vegetal information that delineates vegetation diversity, including its extent, structure, composition, and condition. With the emergence of new high-resolution satellite image sources, Remote Sensing (RS) and Geographic Information System (GIS) have become innovative tools for advanced ecosystem management. The compilation of remotely sensed data facilitates comprehensive analyses of Earth-system function, patterns, and changes at local, regional, and global scales over time. Such data also establish a crucial link between in-depth, localized ecological research and the broader contexts of regional, national, and international conservation and management of biological diversity (Elhag, 2017).

This study aims to comprehend the shifts in land use/land cover within Morshi Taluk, Amravati District. The focus is on mapping the land use/land cover status of Morshi Taluk from 2014 to 2022. The objective is to identify the land consumption rate and changes, especially in built-up areas. Additionally, utilizing Geographic Information System and Remote Sensing data, the study seeks to anticipate potential alterations in this status over the next decade.

Study area

This research focuses on the Morshi Taluk in the Amravati District, Maharashtra. The study encompasses an area of approximately 809.10 sq.km, situated between 21° 14' 16" to 21°25' 23"N latitude and 77°07' 44" to 77°53'24"E longitude (Fig.1)

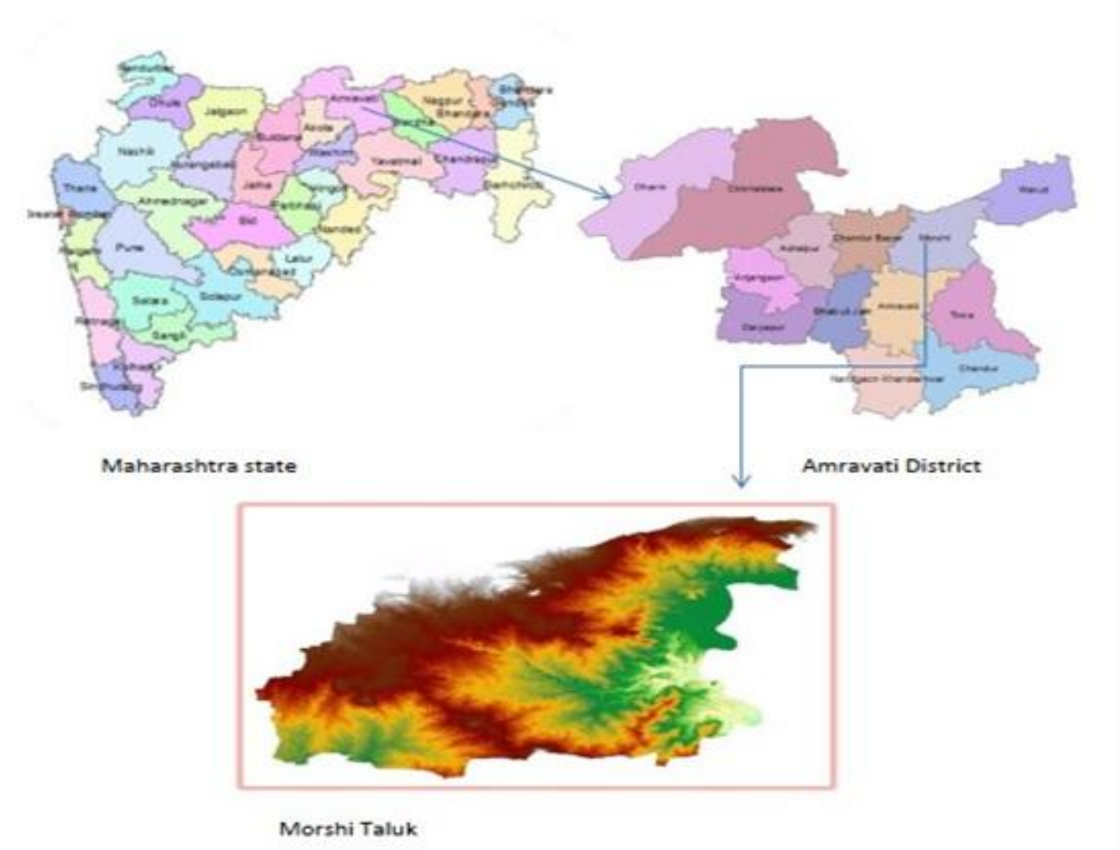

Figure 1: location map of study area

Datasets

The study utilized Landsat 8 OLI/TIRS C2 Level-2 Images for the years 2014 and 2022, featuring a resolution of 30 meters. These images were obtained freely from the Landsat archive on the United States Geological Survey (USGS) website, accessible through (https://glovis.usgs.gov/) and (https://earthexplorer.usgs.gov/) (Chavez et al., 1991; Gutman et al., 2008). The Landsat data underwent both visual and digital interpretation using ArcGIS 10.8 software, employed for the processing, analysis, and integration of spatial data. The study aimed to achieve the following objectives:

Create Land Use Land Cover mapping from satellite images of 2014.

Create Land Use Land Cover mapping from satellite images of 2022.

Determine the trend, nature, rate, location, and magnitude of land use/land cover change.

Methodology

In this study, Image processing and visual interpretation techniques were employed for Land Use/Land Cover classification using digital data and standard False Colour Composite (FCC) satellite images. The classification involved the utilization of a Standard False Colour Composite (FCC) for Landsat TM images, mapping land use/land cover for the years 2014 and 2022. The interpretation process considered aspects such as shape, size, tone/colour, texture, pattern, and location of specific features on the satellite imagery. Land Use/Land Cover (LULC) maps were generated using the supervised classification method with the maximum likelihood algorithm (Rawat and Kumar, 2015). The land cover maps for the selected years were created by applying a multi-sectoral supervised classification algorithm to Landsat sensor data (Lucas et al., 2007). Landsat 8 (OLI_TIRS) satellite images, featuring seven and eleven bands respectively, were converted into an image using composite bands (Zha et al., 2003). The supervised classification process involved basic methods such as composite band creation, raster copying, cloud removal, mosaic to new raster, extraction by mask, and maximum likelihood image classification (Su et al., 2010). These processes were executed using ArcMap 10.8® software (Fig. 2 and Fig. 3).

The copy raster function was used to eliminate the background of images, rendering a transparent background, serving as a pre-processing step for image classification. Haze reduction was addressed in this phase, and the image enhancement technique employed histogram equalization. Cloud cover and haze conditions were deemed acceptable, as they were minimal across all images. To create an accurate aerial representation of the study area, the study utilized image mosaic to a new raster in ArcMap 10.8® software, consolidating Landsat images into one comprehensive representation (Hood and Bayley, 2008). The extract by mask tool was employed to isolate the desired location (Magesh and Ch, 2012; Ramírez-Villegas and Bueno Cabrera 2009).

Image classification

In this study, images underwent classification into four major classes: water bodies, built-up (urban areas), barren soil (wasteland), and crop land. The standard "false-color" composite for Landsat 8 TM satellite images, comprising bands 5, 4, and 3, was employed (Crosta and Moore, 1989; Tamouk et al., 2013; Dwivedi and Rao, 1992). For Landsat 8 TM false-color composite in Natural Color (bands 4, 3, 2), which closely resembles what the human eye perceives, greenery appeared as green, with healthier vegetation appearing brighter. Urban features appeared white and dark, and water displayed as dark blue or black (Elhag, 2017; Mwaniki et al., 2015; Tamouk et al., 2013; Dwivedi and Rao, 1992). To facilitate the selection of pixels for each land use and land cover category, a substantial number of pixels were chosen in this study. Ultimately, the maximum likelihood supervised image classification method was applied using ArcGIS software.

Change detection:

Change detection analysis involves a diverse array of methods employed to recognize, characterize, and quantify disparities between images of the same scene captured at distinct times or under varying conditions. Many of these tools can be utilized either independently or in combination, forming part of a comprehensive change detection analysis. The change detection process typically follows a straightforward approach, measuring alterations between a pair of images representing an initial stage and a final stage. Change detection statistics, often averaging classification images, are commonly employed to compute the difference map for the images.

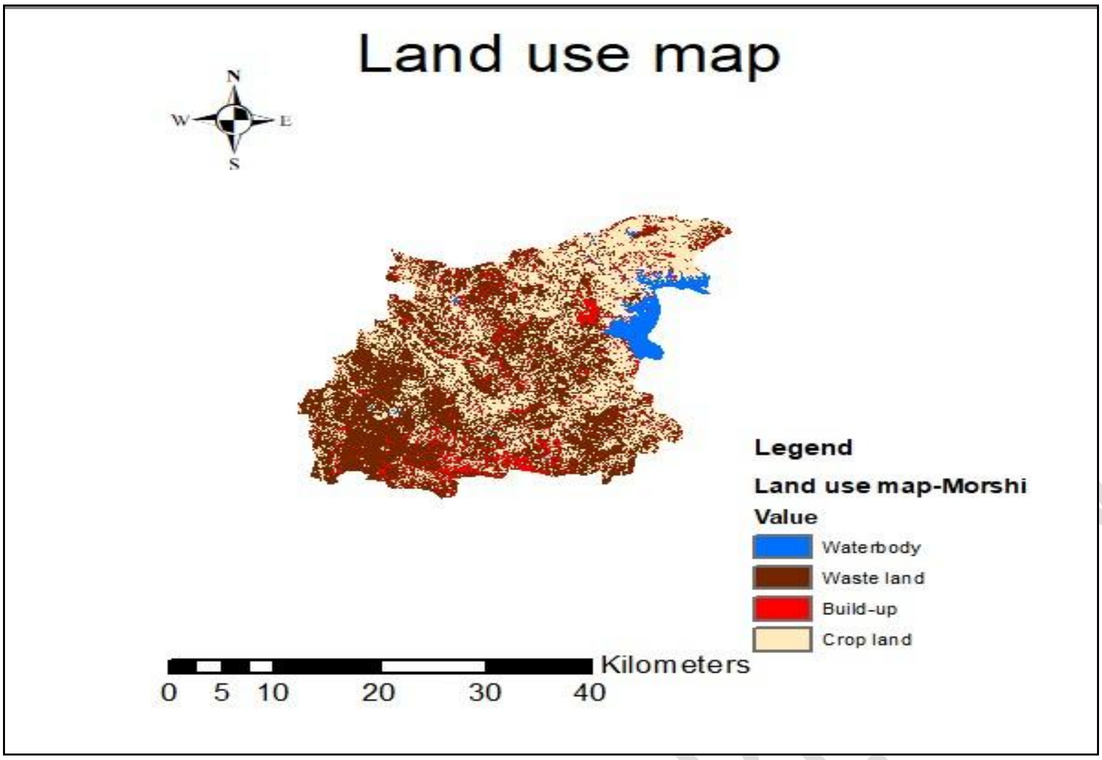

Figure 2. Map showing the Land use categories for the year 2014

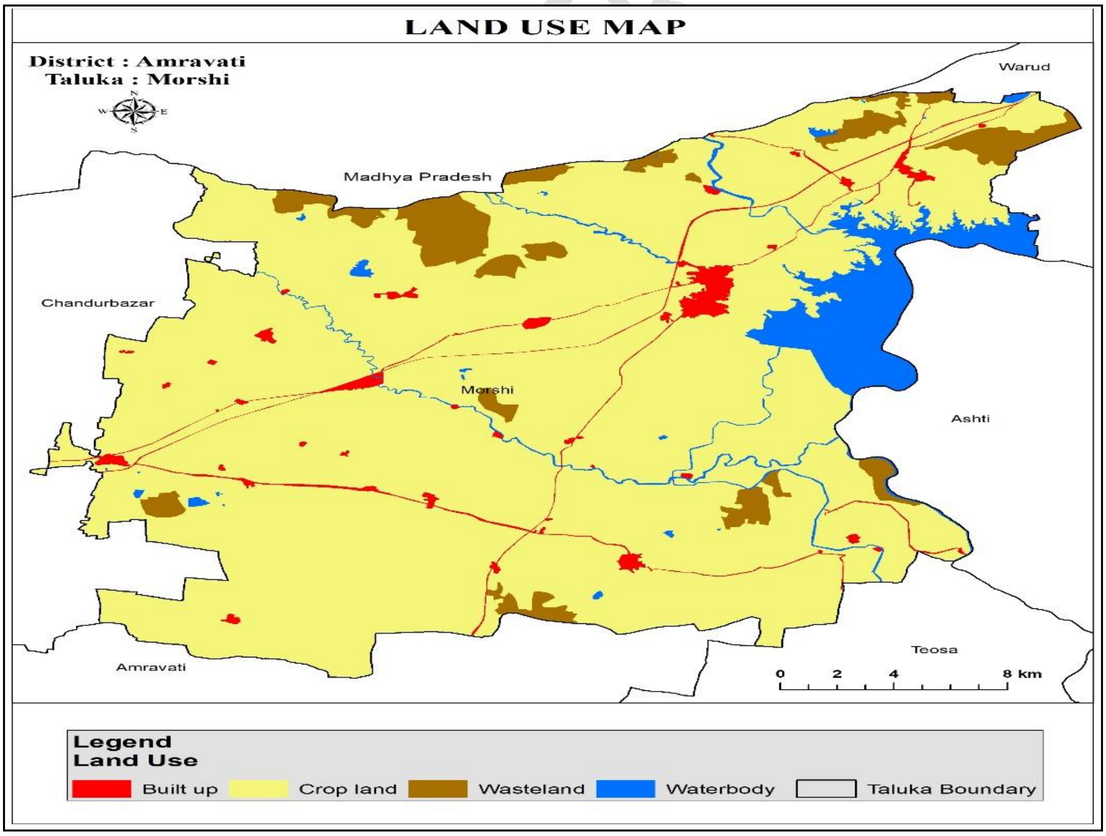

Figure 3. Map showing the Land use categories for the year 2022

Results and Discussion

Applying the maximum likelihood and multi-sectoral supervised classification algorithm, Land Use/Land Cover (LULC) maps for the years 2014 and 2022 are presented in Figure 2 and Figure 3, respectively. In 2014, the built-up area constituted 1.67% of the total land, and it experienced an increase of approximately 0.7% by 2022. Over the course of 10 years, the agricultural (crop land) area decreased by 2.98%. Waste land, which accounted for 4.96% of the total area in 2014, saw an increase of nearly 0.34% by 2022. Chakravarty et al., 2012 observed that the population growth and urbanization resulted in significant reductions in agricultural land and the study reveals that the urban area expanded by 5.18% from 1990 to 2019. Hasan et al. (2013) noted a more substantial increase in the urban area, from 474.95 to 876.16 km^2 between 2000 and 2010. Hanewinkel et al., 2013 noted Barren soil showed no significant changes from 1990 to 2019 and also in the first 20 years (1990 to 2010), the vegetation area increased by approximately 3.36%, but from 2010 to 2019, this area experienced a decline of 0.9%. The water body, constituting 3.94% of the total area, increased by almost 1.94% over the decade. Rai et al. (2017) observed that decrease in permanent wetlands from 4.15% to 1.16% between 1967 and 2010 in their research paper from 2017. Similar result observed by Islam and Gnauck, 2009; Chatterjee et al., 2015; Mukhopadhyay et al., 2006.

Table 1. Area under different land use / land covers categories during 2014-2022

Land Use Land Cover Classes	**2014 (Ha)**	**Area (%)**	**2022 (Ha)**	**Area (%)**
Built-up	1347	1.67	1907	2.37
Crop land	71875	89.43	69473	86.45
Waste land	3974	4.96	4261	5.30
Water body	3171	3.94	4726	5.88
Total	**80367**	**100**	**80367**	**100**

Conclusion:

Land is a crucial natural resource essential for sustaining life, and monitoring Land Use/Land Cover (LULC) changes is instrumental in planning and implementing strategies to conserve land cover. This study leverages Landsat 8 OLI/TIRS satellite images and utilizes ArcGIS software techniques to quantify and calculate land cover changes in Morshi Taluk, Amravati

District, from 2014 to 2022. The research identifies that land use changes in the study area have had a significant negative impact on both society and the environment. Rapid urban development has led to a reduction in agricultural land, vegetation. The transformation of agricultural and vegetation areas is attributed to the expansion of residential areas, altering the livelihood patterns of the local population. The use of hybrid seeds and pesticides by farmers to enhance productivity has resulted in environmental pollution. Urbanization has encroached upon water bodies due to overpopulation and development, with water bodies being filled for cultivation and urban purposes. Deforestation for infrastructure needs and fuel further exacerbates the environmental impact. Geographic Information System (GIS) and Remote Sensing (RS) technologies were employed to process and analyze the data, ultimately generating maps. The results offer crucial information to relevant line departments, aiding policymakers, environmental management groups, and the general public in comprehending the changing landscape. The integration of GIS and remote sensing technologies is affirmed as an effective tool for land cover planning and management. The quantification of LULC changes in the Morshi area serves as valuable information for environmental management, facilitating informed decision-making and understanding of the surrounding environment.

Reference:

Chatterjee, N., Mukhopadhyay, R., & Mitra, D. (2015). Decadal changes in shoreline patterns in Sundarbans, India.

Chakravarty, S., Ghosh, S. K., Suresh, C. P., Dey, A. N., & Shukla, G. (2012). Deforestation: causes, effects and control strategies. *Global perspectives on sustainable forest management*, *1*, 1-26.

Crosta, A. P., & Moore, J. M. (1989). Geological mapping using Landsat thematic mapper imagery in Almeria Province, South-east Spain. *International Journal of Remote Sensing*, *10*(3), 505-514.

Chavez, P., Sides, S. C., & Anderson, J. A. (1991). Comparison of three different methods to merge multiresolution and multispectral data- Landsat TM and SPOT panchromatic. *Photogrammetric Engineering and remote sensing*, *57*(3), 295-303.

Dwivedi, R. S., & Rao, B. R. M. (1992). The selection of the best possible Landsat TM band combination for delineating salt-affected soils. *International Journal of Remote Sensing*, *13*(11), 2051-2058.

Gutman, G., Byrnes, R. A., Masek, J., Covington, S., Justice, C., Franks, S., & Headley, R. (2008). Towards monitoring land-cover and land-use changes at a global scale: The Global Land Survey 2005. *Photogrammetric Engineering and Remote Sensing*, *74*(1), 6-10.

Jaiswal, R. K., Saxena, R., & Mukherjee, S. (1999). Application of remote sensing technology for land use/land cover change analysis. *Journal of the Indian Society of Remote Sensing*, *27*, 123-128.

Hood, G. A., & Bayley, S. E. (2008). Beaver (Castor canadensis) mitigate the effects of climate on the area of open water in boreal wetlands in western Canada. *Biological Conservation*, *141*(2), 556-567.

Elhag, M. (2017). Consideration of landsat-8 Spectral band combination in typical mediterranean forest classification in Halkidiki, Greece. *Open Geosciences*, *9*(1), 468-479.

Hasan, M. N., Hossain, M. S., Islam, M. R., Bari, M. A., Karim, D., & Rahman, M. Z. (2013). Trends in the availability of agricultural land in Bangladesh. *Soil Resource Development Institute (SERDI), Ministry of Agriculture, Bangladesh, Dhaka. Available from URL: http://www. nfpcsp. Org/agridrupal/sites/default/files/Trends-in-the-availability-ofagricultural-land-in-Bangladesh-SRDI-Supported-by-NFPCSP-FAO. pdf (accessed 17.05. 15.)*.

Hanewinkel, M., Cullmann, D. A., Schelhaas, M. J., Nabuurs, G. J., & Zimmermann, N. E. (2013). Climate change may cause severe loss in the economic value of European forest land. *Nature climate change*, *3*(3), 203-207.

Islam, S. N., & Gnauck, A. (2009). Threats to the Sundarbans mangrove wetland ecosystems from transboundary water allocation in the Ganges basin: A preliminary problem analysis. *International Journal of Ecological Economics & Statistics*, *13*(9), 64-78.

Lucas, R., Rowlands, A., Brown, A., Keyworth, S., & Bunting, P. (2007). Rule-based classification of multi-temporal satellite imagery for habitat and agricultural land cover mapping. *ISPRS Journal of photogrammetry and remote sensing*, *62*(3), 165-185.

Magesh, N. S., Chandrasekar, N., & Kaliraj, S. (2012). A GIS based automated extraction tool for the analysis of basin morphometry. *Bonfring Int J Ind Eng Manag Sci*, *2*(1), 32-35

Mukhopadhyay, S. K., Biswas, H. D. T. K., De, T. K., & Jana, T. K. (2006). Fluxes of nutrients from the tropical River Hooghly at the land–ocean boundary of Sundarbans, NE Coast of Bay of Bengal, India. *Journal of Marine Systems*, *62*(1-2), 9-21.

Mwaniki, M. W., Moeller, M. S., & Schellmann, G. (2015). A comparison of Landsat 8 (OLI) and Landsat 7 (ETM+) in mapping geology and visualising lineaments: A case study of central region Kenya. *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, *40*, 897-903.

Su, X., He, C., Feng, Q., Deng, X., & Sun, H. (2010). A supervised classification method based on conditional random fields with multiscale region connection calculus model for SAR image. *IEEE Geoscience and Remote Sensing Letters*, *8*(3), 497-501.

Rawat, J. S., & Kumar, M. (2015). Monitoring land use/cover change using remote sensing and GIS techniques: A case study of Hawalbagh block, district Almora, Uttarakhand, India. *The Egyptian Journal of Remote Sensing and Space Science*, *18*(1), 77-84.

Rai, R., Zhang, Y., Paudel, B., Li, S., & Khanal, N. R. (2017). A synthesis of studies on land use and land cover dynamics during 1930–2015 in Bangladesh. *Sustainability*, *9*(10), 1866.

Tamouk, J., Lotfi, N., & Farmanbar, M. (2013). Satellite image classification methods and Landsat 5TM Bands. *arXiv preprint arXiv:1308.1801*.

Zha, Y., Gao, J., & Ni, S. (2003). Use of normalized difference built-up index in automatically mapping urban areas from TM imagery. *International journal of remote sensing*, *24*(3), 583-594.