DOI: 10.24996/ijs.2022.63.5.40

ISSN: 0067-2904

Effect of Urban Expansion Indices Change by (R.S.) on Height of Convective Radix Layer around Baghdad Airport (Iraq)

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Received: 12/4/2021 Accepted: 15/9/2021 Published: 30/5/2022

Abstract

Change in structure of land surface can affect atmospheric boundary layer and formation of internal boundary layer. This will change shear stresses and turbulent boundary layer. Change in low level wind shear and turbulent can affect air craft performance and has potentially adverse effects on flight safety during landing and taking-off stages. In this study, change in land area around Baghdad Airport and its effects on structure of boundary layer and radix layer through summer season (July from years 1985 and 2014) is examined. The examination is done through atmospheric data of radiosonde (at altitude more than 1500 m) and remote sensing by Landsat 5 and 8 images (circular region around airport has radius 3.250 km and the airport is considered the center of this circle). From analysis of hourly wind speed and temperature profile with height observed by radiosonde, change in convective radix layer can be determined at this period resulted from change structure of boundary layer depending on characteristic of landcover used in supervised classification. Building area increases from 18% in 1985 to 41% in 2014. These results enforced by positive values of built up index BI, that showed a decreases in 2014. All these elements changed convective radix layer from less than 500 m in summer 1985 to more than 700 m. There is a large fluctuation in radix layer height depended on convective and friction velocity at 2014 data. Thus indirect change in structure of convective layer will affect navigation movement of Baghdad International Airport.

Keywords: Built Up Index, Radix Layer, Convective Layer, Remote Sensing, Baghdad

تأثير تغير مؤشرات التوسع الحضري باستخدام (التحسس النائي) على ارتفاع طبقة الرادكس الحملية حول مطار بغداد (العراق)

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علوم الجو, كلية العلوم,المستنصرية, بغداد, العراق

الخلاصة

يمكن أن يؤثر التغيير في بنية سطح الأرض على الطبقة المحاددة الجوية وتشكيل طبقة محاددة داخلية ، وهذا سيؤدي إلى تغيير اجهاد القص وتغير الاضطراب في الطبقة المحاددة. يمكن أن يؤثر التغيير في مستوى قص الرياح المنخفض والاضطراب على أداء وحركة الطائرة ومن المحتمل ان يكون له تأثيرات واسعة على

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سلامة الطيران أثناء مرحلتي الهبوط والإقلاع. في هذه الدراسة ، تم تقييم التغير في مساحة الأرض حول مطار بغداد وتأثيره على تركيب الطبقة المحاددة وطبقة الرادكس الحملية خلال فصل الصيف (تحديدا شهر تموز من عام 1985 و 2014) من خلال بيانات الراديوسوند (الى ارتفاع يصل الى 1500 متر) بالإضافة الى بيانات الاستشعار عن بعد باستخدام صور الفضائية للأقمار لاندسات 5 و 8 (في منطقة دائرية حول المطار يبلغ قطرها 3.250 كم ، ويعتبر برج المطار مركزًا لهذه الدائرة). من خلال تحليل المقطع العمودي الساعي لسرعة الرياح ودرجة الحرارة المرصودة من خلال الراديوسوند ، يمكن تحديد التغيير في طبقة الرادكس الحملية في هذه الفترتين الناتج عن تغيير في تركيب الطبقة المحاددة اعتمادا على خصائص غطاء الارض ، حيث بين التصنيف الموجه ان مساحة الاراضي المبنية كان 18٪ في عام 1985 وازدادت إلى 41٪ في عام 2014 . هذه النتيجة تم تعزيزها من مؤشر البناء BI ، حيث هنالك تناقص للقيم الموجبة لهذا المؤشر خلال سنة 2014. كل هذه العناصر يمكن ان تغير طبقة الرادكس الحملية الحراري وتؤدي الى زيادة ارتفاعها من أقل من 500 متر في تموز 1985 إلى أكثر من 700 متر في تموز 2014 ، من ناحية اخرى وجدت الدارسة ان هناك تذبذب كبير في ارتفاع طبقة الرادكس اعتمادا على السرعة الحملية الحراري والاحتكاك خلال تموز 2014 ، ان التغير الغير المباشر في تركيب الطبقة الحملية للرادكس سوف تؤثر على حركة الملاحة في مطار بغداد.

1. Introduction

Urbanization known as conversion of land to use by human being. This associated by growth of population and economy. This conversion has a great impact on climate because building and road cover absorbed large rate of solar radiation at daytime and released at night[1]. Therefore, urban areas record high temperature compared with surrounding rural area. This is called urban heat island. Interaction between land and atmosphere can change condition of lower atmosphere. This effect can extent to few thousand meters and related to response directly to surface forcing, called Atmospheric Boundary Layer (ABL) [2][3]. Motion in ABL have various scales, but turbulent scale conveyance plays an vital part in diurnal differences of meteorological elements[4]. This turbulent make as bridge to exchange heat, moisture, energy and particulates substances between ground and air, and mixed multi layers such as troposphere, lithosphere and biosphere [5]. ABL can be categorized according to its thermodynamic properties and turbulence characteristics into three types: unstable, neutral, and stable. Surface heated by sun creates an atmospheric unstable stratification above ground and develops an unstable boundary layer. In this situation turbulence really active due to effort prepared by buoyancy[6]. In unstable boundary layer, thermal bubbles are considered basic to form turbulence and make meteorological elements nearly uniform through vertical profile distribution in atmosphere. Because importance of thermal bubbles ABL, it is sometimes called convective boundary layer or mixed layer[7]. When lower atmosphere keeps neutral stratification, ABL called neutral boundary layer, when convective layer be ignored. The stable boundary layer is formed by radiative cooling of surface with an inversion layer at night[8]. In aviation, convection currents can cause vibration in airplane flying at low altitudes in warmer weather[9]. In a low flight over changing surfaces, pilot will face updrafts over pavement or barren places and downdraft over vegetation and water. Ordinarily, this can be avoided by flight at higher altitudes[10]. Convection currents also cause difficulty in making landings, as they affect rate of descent, for example, a pilot flying a regular glide frequently tends to land short of or overshoot intended landing spot, depending on presence and severity of convection currents[11]. Convective current depends on depth of convective layer, its type, land surface underline, and overall elevation of convective boundary layer (below 2000–3000). While elevation of stable boundary layer is no more than 500 m [12]. The height of boundary layer depends on Topographical location, weather and climate circumstances, and modifications underlying surface, all intensification complication boundary layer height [13]. There are many studies covered convective boundary layer in Baghdad city (Iraq) by using radiosonde. For example, Al-Shamary Hussein Ali Hatam 2006 estimated mixing height (z_i) over Baghdad Airport by using radiosonde data of wind speed and temperature for upper atmosphere at times 00.00 GMT and 12.00 GMT. Results showed decreasing (z_i) near surface greater than adiabatic laps rate and gradually reaching dry adiabatic laps rate (- 0.98 C˚ per 100 m). The decreasing of temperature (dT/dz) during summer months were (2C˚ – 2.5 C˚) per 100m while decrease of (1C˚ – 1.5 C˚) per 100m were observed during winter months. Mixing height during winter months reaching value of (364 m) on January, whereas mixing height (z_i) reaching its max value during Summer time with height of (2297 m) on July[14]. Huda Majeed Mohammed Al-Hasnawi studied characteristics of the convective mixed layer which including the Radix Layer (RL) and Uniform Layer UL, and applied RL similarity equations for wind profile using Radiosonde data of wind speed for upper atmosphere at 12:00 GMT for height more than 2000 m in the year 1987. Wind profile showed that RL differs from run to run and it is in the range of (300-400)m while wind speed within the UL is about (3-10)m/s with more frequent in the range of (6-8)m/s [15]. Nagham Abbas 2011, studied spatial distribution of boundary layer height above Iraq map through the period from 1989-2009 using data from European Center for Medium-Range Weather Forecast (ECMWF). Noting that there is a strong linear relationship between monthly average of boundary layer depth and monthly averages of air temperature with values range between 0.889-0.960 as a linear correlation coefficient [16]. Haraj S. A. and Al-Jiboori M. H. calculated Roughness length parameters and urbanization in Baghdad city in 2019 by ultrasonic anemometer installed at Mustansiriyah University building. Results showed ranges of variable heights of rough elements z_h (9.2-13.8)m, zero distance height z_d (4.3- 8.1) m and roughness length z_o (0.24-0.48)m [17]. In other hand, Hildebrand, P. H., & Ackerman, B. dealt with effect of urban area on convective boundary layer by using aircraft. The study found the best conditions to study this case is at undisturbed weather conditions and low wind speed, where urban effect on turbulent profile for heat, moisture, momentum and turbulent intensity is very clear [6]. The aim of this study is to evaluate effect of change in urban roughness on the convective profile of radix layer and mixed layer around area of Baghdad Airport by using upper meteorological data (radiosonde) and satellite images data.

2. Location:

Region of Study covered Baghdad International Airport and its surrounding area. Baghdad Airport bounded Baghdad's city center and located in the south-west of Baghdad city center. Figure 1 shows boundary map of Baghdad city center. This photo is requested from sentinel satellite at resolution 10 m and composite bands 4 3 2 in Aug. 2020. Regional extend of Baghdad Airport bounded by longitude from 44.15° – 44.55° and latitude 33.45° – 33.134° (Figure 2). This figure extracted from part of Figure 1. Data used were obtained from weather station located in area near official Baghdad International Airport. Latitude and longitude of airport station is 33.14°N and 43.34°E respectively, and elevation from sea level about 33 m. This station have long archives of recorded data considering Baghdad province and its surrounding. It is located about 16 km west of Baghdad downtown.

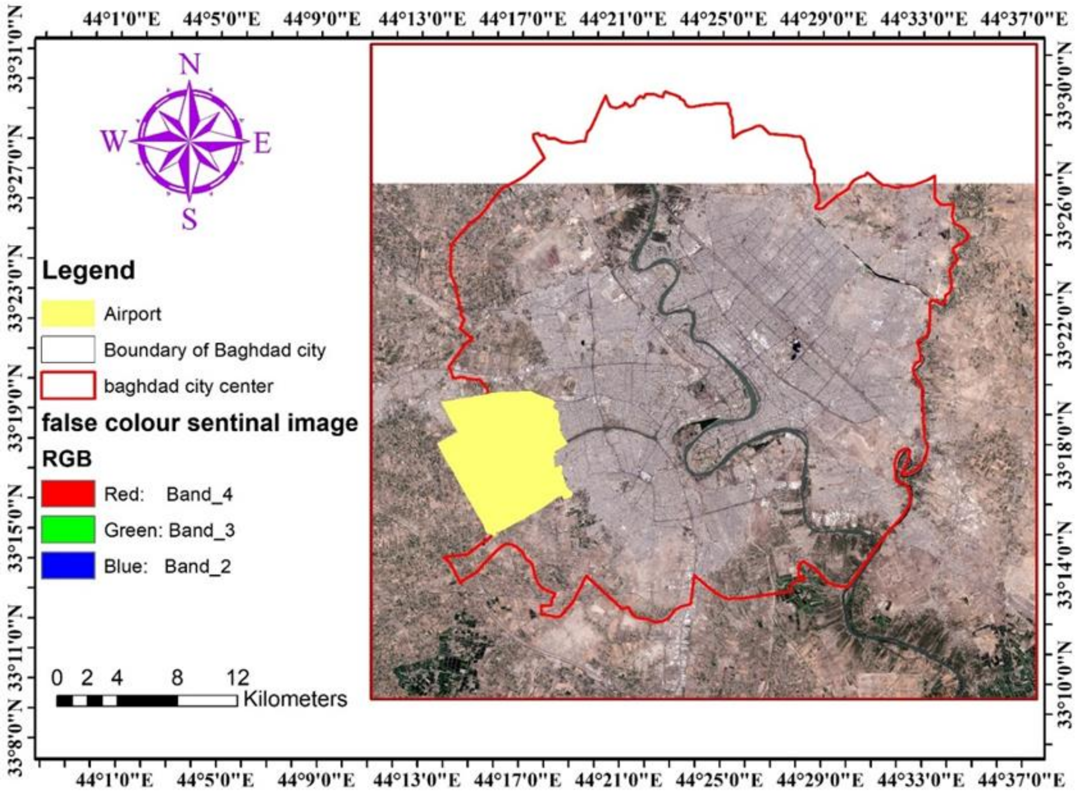


Figure 1- Satellite composite image (bands 4, 3, 2) from sentinel show Baghdad City center and international Baghdad Airport

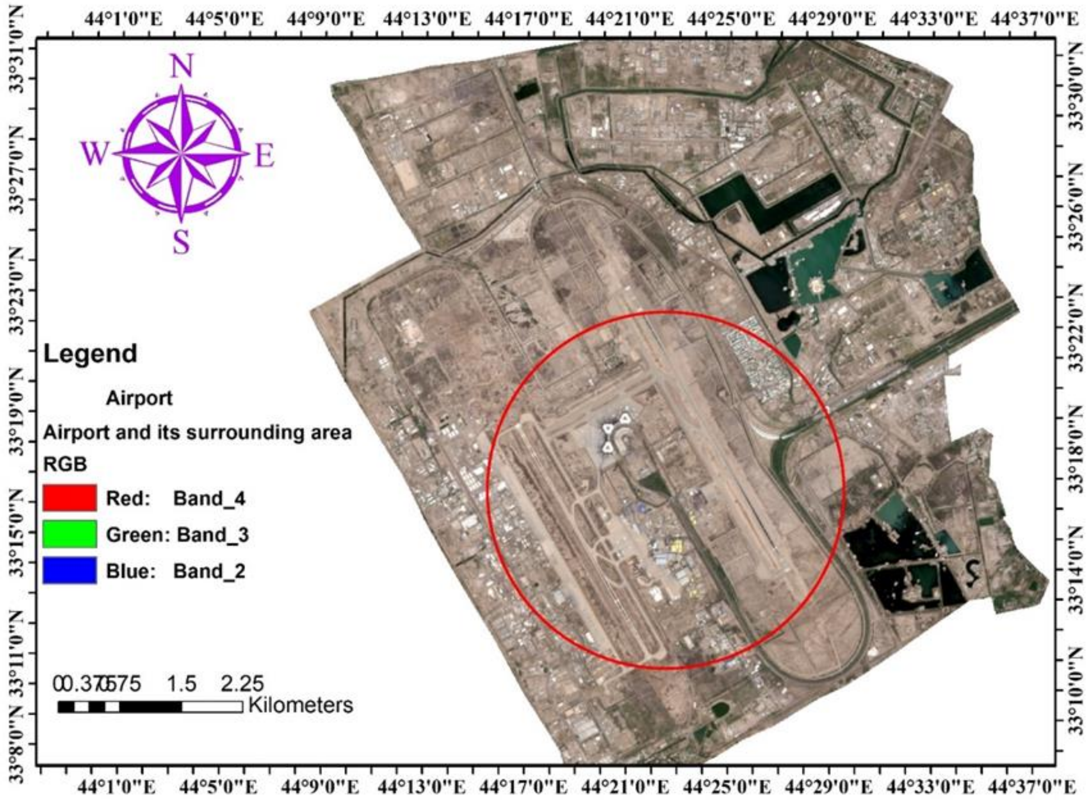


Figure 2- Baghdad International Airport region and its surrounding extracted from Figure - 1(yellow color)

3. Data:

Data sources of this study are divided into two parts. First source is atmospheric vertical profile to describe convective radix layer. Second source is monitoring land use of earth surface of airport's surrounding region. The second source is used as proceeding to draw relationship of effects of boundary layer convection through long period.

3.1 Radiosonde data:

The Radiosonde is a consumable, balloon-borne device that deals with vertical profile of meteorological elements and communicates with a ground based processing station, Figure (3a). Vertical profiles are characteristically observed twice a day and are reprocessed in global weather observing system providing inputs to numerical forecast models. The radiosonde sensor package usually deals with variation of altitude for temperature, humidity, and pressure as the balloon ascends from land or ocean surface to altitudes up to about 30 km (a pressure about 11 hectopascals, hPa) [18]. Radiosonde releases in Baghdad Airport is not continuous but there is an old data started in 1983. In this study, year 1985 and 2014 at 12 GMT are selected to monitor changes in convective boundary layer at radix region. All these data are from Iraqi Meteorological Organization and Seismology (IMOS). Radiosonde data in 2014 are obtained by help of Win9000 software. It is provided in a form of variable levels and processed in many screens. Figure 3b, shows temperature and humidity profile with time released and pressure in millibar. This software's screen does not have vertical height, thus it needs to transfer pressure data to height by hydrostatic equation [19]:

$$Z = -\frac{T}{a}\ln\left(\frac{p}{p_0}\right), \quad (1)$$

Where Z = distance height in meter, T = temperature measured at level height, a=constant equal to 0.0342 k/m, p=pressure at height Z, p_0=pressure at sea level

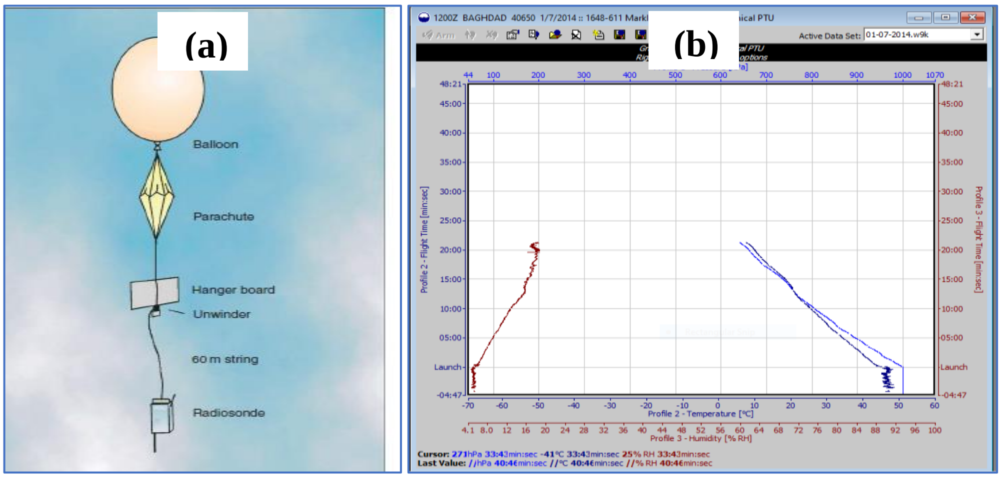


Figure 3- (a) Composition parts of radiosonde to monitor weather profile, (b) screen in program Win9000 to displace data, used in radiosonde weather station.

3.2 Satellite images data

Data also obtained from satellite images Landsat 8 and Landsat 5, (Landsat 8 is used because Landsat 5 is stopped working by the end of 2013). The two satellites reprocessed to monitor any change in urban area through period from 1985 to 2014 concerning Baghdad International Airport and surrounding area. Most images obtained at summer months where sky is clear and cloud rate is nearly zero.

4. Methodology:

4.1 Urbanization index:

There are many techniques that comprise improvement of different indices to enhance a precise built-up area and determination of optimal threshold level to distinct built-up areas from other land cover types. Common indices for representing built-up and other land cover types in urban areas, such as the Normalized Difference Built-Up Index (NDBI) and Normalized Difference Vegetation Index (NDVI). These indices use short wave infrared (SWIR), near infrared (NIR), and infrared waves (RED) to calculate built up area index (BI). This specified urban areas expansion according to the equations [20].

$$NDBI= (SWIR-NIR)/(SWIR+NIR) \quad (2)$$

$$NDVI= (NIR-RED)/(NIR+RED) \quad (3)$$

$$BI=NDBI-NDVI \quad (4)$$

SWIR: short wave radiation taken Bands number 6 and 5 in Landsat 8 and 5 respectively for NDBI.
NIR: near infrared radiation taken bands number 5 and 4 for Landsat 8 and 5 respectively for NDBI, but taken 5 and 4 bands for Landsat 8 and 5 in NDVI.
RED: Infrared radiation taken bands numbers 4 and 3 in Landsat 8 and 5 for NDVI

4.2 Effect of roughness length (urban area) on boundary layer structure:

Roughness construction can mainly affect atmospheric boundary layer through two methods:

4.2.1 Mechanical effect:

When air flow over a rough surface, following layers usually recognized, see Figure 4:
1) A Roughness Sublayer (RS): in this layer, wind speed is horizontally inhomogeneous, because airflow influenced by the discrete irregularity elements.
2) A Inertial Sublayer (IS): in this layer flow is horizontally homogeneous and wind varies only with height (z).
The depth of the RS is dependent on surface geometry, typically its height have 2-5 times the height of roughness elements. In Roughness Sublayer and below the height of the elements themselves there exists a canopy layer, where air flow is inhomogeneous distributed. The shear stress in the RS profile also distributed in horizontally Inhomogeneous. This case differs in the Inertial Sublayer (IS) overhead, where shear stress is nearly constant with height (10%) and horizontally homogenous, see Figure 4 [21] [22]. Thus roughness element is effected in mechanical pattern on horizontal wind movement.

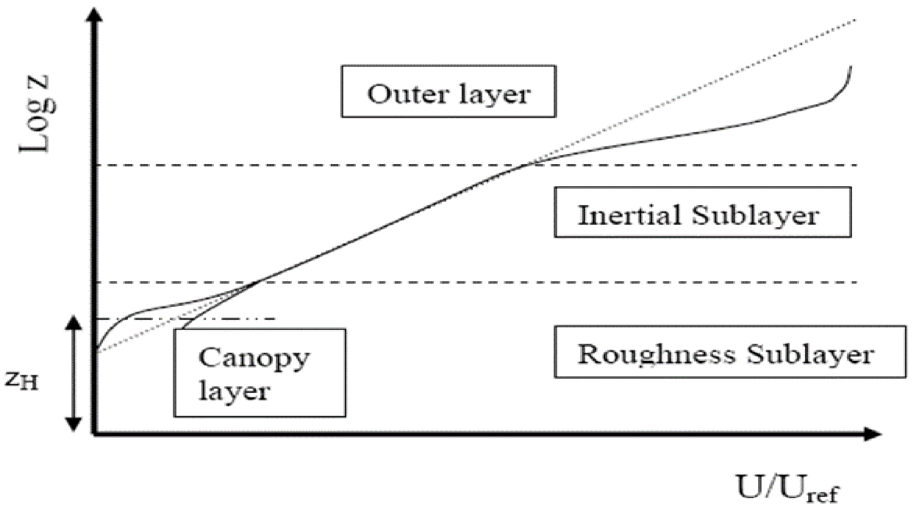


Figure 4- Wind shape above an irregular surface, consist from Roughness sublayer and inertial sublayer. z_h is refer to the roughness element height, U/U_{ref} refer to normalized x-axis, where U_{ref} reference surface wind.

4.2.2 Convective effect:

Field experiment data and numerical simulations show that in urban area penetration of mixed layer is the greatest over vital part of the city. Difference in buoyancy convection between urban area and its surrounding will make convergent flow near urban center and divergent outflow in upper part of the mixed layer and below upper inversion height. In addition to that large scale eddy motions and inversion waves can created from different change in turbulent structure from being shear dominated over outer part of urban area to plume dominated near urban center. Buoyancy and turbulence driven atmospheric circulations are influenced by the following factors: (1) difference in heat flux between urban and rural areas; (2) background stratification, which is indicated by buoyancy frequency and (3) urban morphology such as diameter of built up region of urban area, roughness of urban area (defined by z_o), building-area concentration and construction frontal area density[23]. There many terms responsible for define turbulent structure in urban area such as friction, Deardorff velocity, radix, and mixed layer height.

4.3 Friction and Deardorff Velocities:

Friction velocity known as turbulent velocity of boundary layer and given as[24]:

$$u_* = kM_z \left[\ln\left(\frac{z}{z_0}\right) - \psi_m\left(\frac{z}{L}\right)\right]^{-1} \tag{5}$$

Where k is Van Karman's constant equal to 0.4, z_0 is the roughness length, z/L is the atmospheric stability parameter. M_z Wind speed at height z, ψ_m correction factor depend on the stability consider as z/L, thus[25][26]:

If atmospheric condition is unstable and $-2 \leq z/L \leq 0$

$$\psi_m = 2\ln\left(\frac{1+\phi_m^{-1}}{2}\right) + \ln\left(\frac{1+\phi_m^{-2}}{2}\right) - 2\tan^{-1}(\phi_m^{-1}) + \frac{\pi}{2} \tag{6}$$

Where: $\phi_m = (1 - 16\,(\frac{z}{L}))^{-\frac{1}{4}}$

If atmospheric condition is unstable and $-10 \leq z/L \leq -2$ thus:

$$\psi_m = \frac{3}{2}\ln(\phi_m^{-2} + \phi_m^{-1} + 1) - \sqrt{3}\tan^{-1}\left(\frac{2\phi_m^{-1}+1}{\sqrt{3}}\right) - \frac{3}{2}\ln 3 + \frac{\pi}{3}\sqrt{3} \tag{7}$$

Where: $\phi_m = (1 - 16\,(\frac{z}{L}))^{-\frac{1}{3}}$

In stable condition $\boldsymbol{\psi_m}$ and $\boldsymbol{\phi_m}$ taken values

$\phi_m = 1 + \alpha\,\frac{z}{L}$, $\psi_m = \alpha\,\frac{z}{L}$ Where $\alpha = 5$

In neutral condition, its taken values:

$\phi_m = 1$, $\psi_m = 0$

Parameter ϕ_m refer to non-dimensional wind shear its function of stability parameter z/L.

In other hand w_* known as Deardorff velocity, it is defined as: the convective velocity that measure of lifted thermal current that responsible for vertical transport for the element founded in the surface layer and mixed layer, it's given in equation[19]:

$$w_* = \left[\frac{g}{T} Z_i\,\overline{w'T'}\right]^{\frac{1}{3}} \tag{8}$$

There is a relation between Monin–Obukhov Length L, and friction velocity given as[26]:

$$L = -\frac{u_*^2}{k\frac{g}{T}\overline{W'T'}} \tag{9}$$

Where, g is earth acceleration gravity, T average air temperature in C^0, and $\overline{w'T'}$ is sensible heat flux. From this equation and w_* equation new equation resulted:

$$L = -\frac{1}{k}\left(\frac{u*}{w*}\right)^3 z_i \tag{10}$$

z_i is the altitude of the convective mixed layer, mixed layer define as a height reach to middle entrainment layer that represented by thermal inversion, z_i can calculated from equation [27]:

$$z_i = -C\,\frac{u_*}{|f|} \tag{11}$$

f is Coriolis parameter equal to 8.02 * 10^{-5} for Baghdad city and C is constant and equal to 0.25 for unstable condition.

4.4 Radix layer height:

Radix layer known as the height where the vertical change in horizontal wind is equal to zero, ($\frac{\partial \mathrm{M}}{\partial \mathrm{Z}} = 0$), radix layer can be calculate from equation[28][29]:

$$Z_{RM} = E \ (\frac{u_*}{w_*})^B \ z_i \quad (12)$$

Where E و B is experimental constant, can be estimated for Baghdad city from applying non-linear power regression, on data between non-dimensional wind speed and non-dimension height and find best curve for this data, thus constant value of E=0.52±0.019 and B = 0.61± 0.029 [18].

5. Result and Discussion

5.1 Urban area Change around airport:

In this study, change in topography is analyzed by remote sensing satellite image to test its effect on structure of boundary layer height over international Baghdad Airport area. Two scenes images from Landsat 5 and 8 were taken in this analysis in July 1985 and 2014. All images were downloaded from USGS. Circular shape file was created by ArcGIS to cover area of study (Baghdad Airport and surrounded area) Figure 2. Center shape file of this circular location of atmospheric weather station where radiosonde is released. Radius of this circular area is 3.250 km, Figure 5a. Circular extracted area around Baghdad International Airport is created by false color composite of bands 7, 4, 2 for Landsat 5 and bands 7, 5, 3 for Landsat 8 images, Figure 5 (b and c). These composite images can be used to show accurate rate of change in land use but it gives area of vegetation and also change in land area included increase in urban area change. Landsat images resolution is 30 m. This may not show clear features of land cover, thus clipping composite natural color for the same area from Sentinel 2b, Figure 5a, is used for comparison with other images in 5b,c. Composite false color of Landsat is used in processes of supervised classification for about 400 selected sample and four classes: green land, moist land, dry land, and building used in the classification, Figure 6(a,b). In this classification building areas increased from 18% at July 1985 to 41% at July 2014. This couponed with decreases in green land from 29% to 21%. Normalized Difference Built-Up Index (NDBI) and Normalized Difference Vegetation Index (NDVI), built up Area Index (BI) using two images scene for Landsat 5 and 8 to study change in area of land cover resulted from urban area increases, Figure 7 (a,b). This figure contains two images scene, one on 20-July-2014 taken by Landsat 8, and second from Landsat 5 taken on 21-July-1985. Value of NDBI of Landsat 8 image has a range from -0.398 to 0.258 but Landsat 5 image in 1985 has a range from -0.329 to 0.571. The decreases in the positive value for NDBI is due to increases in other land use/land cover categories especially bare soil ,for example. While negative values range in 1985 is larger because the decrease in other land used/land cover categories particularly Agriculture.

5.2 Calculated Friction and Convective Velocity

Convective Radix layer height can be estimated by two methods. First, representation of vertical temperature profile. Second, from calculation of radix layer by Monin–Obukhov length. In the first case, temperature observations are needed at different heights above airport area in July 1985 and 2014 for comparison. Wind speed is very important index also refer to effect of change in surface area. It is difficult to represent all day’s data, thus average of each layer height about 100m is taken in comparison, see Figure 8. To determine radix convection layer, we need to know the weather factors such as wind speed and temperature with altitude. The method to calculate height of radix convective layer depends on these factors in the first place. In this study, the focus was on summer, specifically July of years 1985 and 2014, Figure (8a,b), It shows behaviour of vertical section of change in wind speed and temperature with altitude, in addition to a comparison between behaviour of these factors during these years and knowing difference in performance of these factors with altitude up to 1500 meters within Baghdad Airport area. During year 1985, temperature decreases from 41.8 at the level of the earth's surface to 25.7 C, at a height of 1500 meters with a standard deviation rate of 1.4 Celsius. For July 2014, temperature is greater and reaches 42.4 Celsius when it rises.

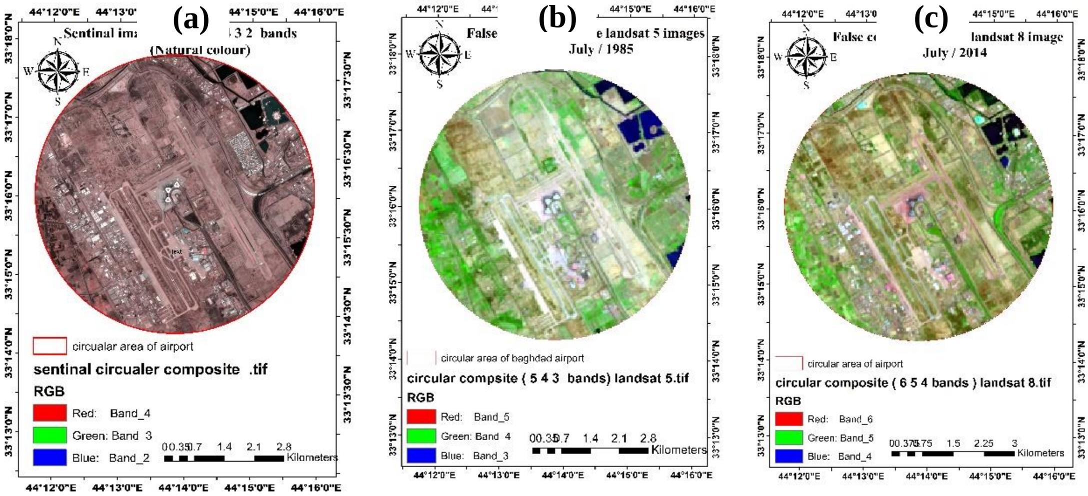


Figure 5 - Show circular area around Baghdad Airport at (a) composite natural color for sentinel image taken at 3-8-2020, (b) composite false color image for Landsat 5 at July 1985, (c) composite false color image for Landsat 8 at July month 2014.

(a) **(b)**

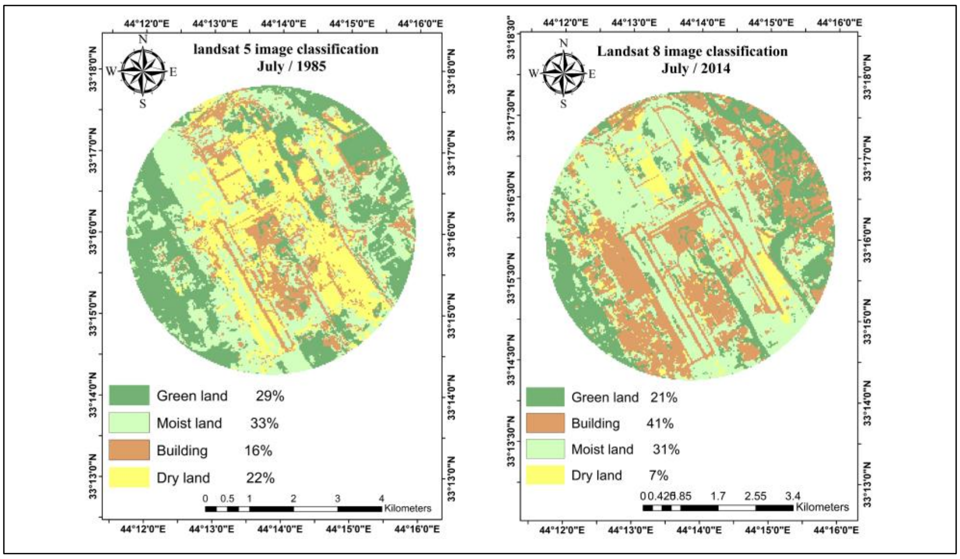


Figure 6 - Show circular area around Baghdad Airport supervised classification composite color image at (a) Landsat 5 and (b) Landsat 8 image.

The average is 100 meters, and it reaches 28 C° at an altitude of 1500 meters, with a data dispersion of up to 3 degrees. Regarding wind speed during July 1985, there is a decrease in wind speed with altitude from 0 to 200 meters, and wind speed ranges from 0.4 meters / second to 9 meters / second, on average, for each altitude from level of 100 meters to 1500 meters.

(a) **(b)**

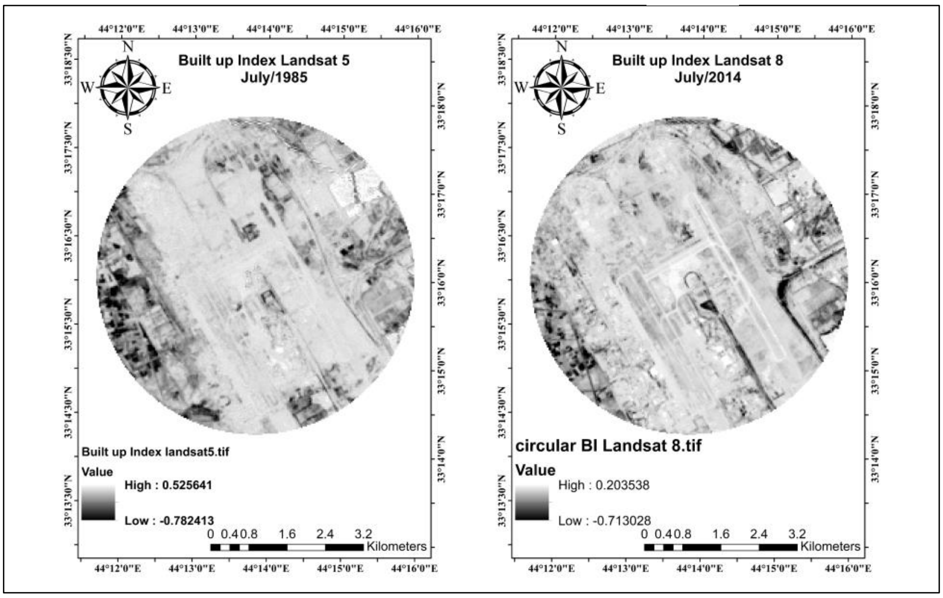


Figure 7- Show circular area around Baghdad Airport, normalized difference built up index (NDBI) applied at two images scene for Landsat 5 and 8 images at (a) Landsat 5 and (b) Landsat 8 image.

The wind speed is homogeneous after the height of 250 meters, and its value ranges between 8 to 8.5 (m/s). Deviation and dispersion from average increases for each level of upper atmosphere with increase in height until it reaches 3.5 meters at the height of 1500 meters. Wind speed during July 2014, and by finding rate for each layer of atmosphere for every 100 meters, we find that there is a fluctuation and change in wind speed through levels of upper atmosphere layers as in the figure. This change in rate is accompanied by a change with the standard deviation of each layer of Atmosphere where the standard deviation ranges from 2.2 m/s to 3.3 m/s, and the highest velocity at 900 meters is about 9 m/s, Figure 8b.

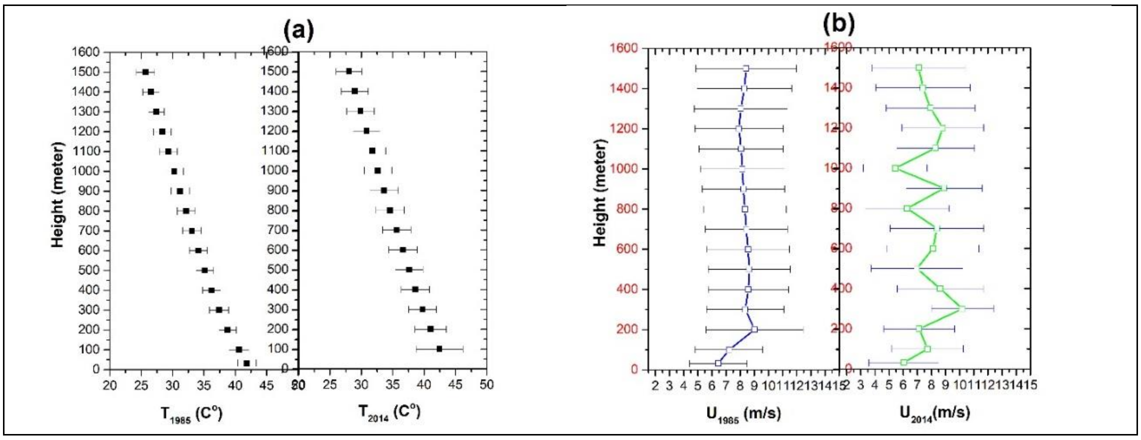


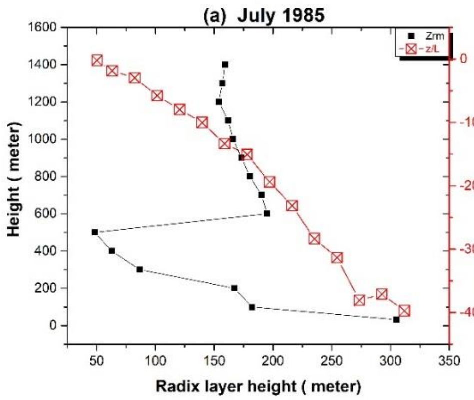
Figure 8- Average and standard deviation at July from 1985 to 2014 for (a) temperature profile and (b) wind speed for area of airport

5.3 Radix layer height:

Convective radix layer can be calculate according to equations from 3 to 10 where equation 10 used to calculate convective radix layer depending on the rate of (u_*/w_*) friction to convective velocity. Also the value of mixed layer height. Figure 8a,b shows the relationship between convective radix layer height with stability z/L . In both cases there is a decreases in the unstable with height. There is a decreases in unstable case from -60 at 200 m to near neutral condition z/L reach to 0 at height z=1400 m at July 2014. While in July 1985 it decreases from -40 at 100m to near neutral z/L equal to 0 at height 1400 m. The stability condition affected the convective radix layer height. In 1985 there was a constant value between 150 200 m, fig 9a. In 2014 there was a change between 120-180 meter, fig 9b. Overall, there is a large fluctuation in the value of convective radix layer at 2014 because large change in convective velocity and friction velocity due to large change in land cover this will be represented in the next paragraph.

5.4 Effect of change in urban expansion on radix layer height:

It is known that there is a change in land cover because of increased human activity. Change in land cover will affect structure of atmospheric boundary layer and turbulent structure over land. Change in roughness of area of Baghdad Airport is very important because most airport landing and layout happened in this area, thus turbulent structure will affect this process in active case. Figures below show that there is a significant change in land cover by decreases Greenland and increase building area and dry land. Turbulent constructed from eddies and shear stress because increases roughness area land and expanded fetch in the cases condition wind speed is very large while in condition where wind speed is small less than 3m/s. turbulent created by plume convective because these area heated more than other and will be create convective plume lifted in air and increases mixed layer height and turbulent in this layer. Studying the change in mixed layer resulted change in land cover is very important to civil planning depending on direction of airplane landing.



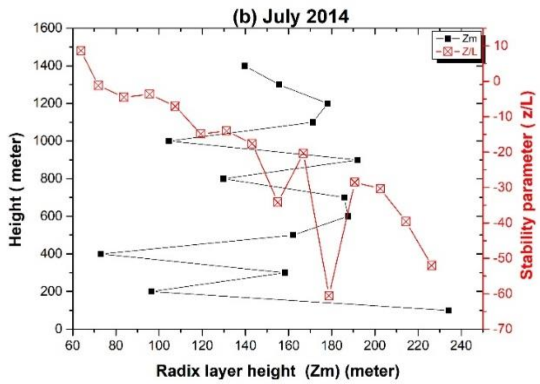


Figure 9- Relationship between radix layer height and stability by Monin–Obukhov through the height profile at (a) July 1985 (b) July 2014.

6. Conclusion:

The boundary layer is considered as a portion of atmosphere that is straight influenced by surface. Modification in air above surface requires period from 30 minutes to hour. This change include friction velocity, humidity and also air pollution. The heterogeneity in Earth's surface means that airflow is frequently facing variations in surface roughness. Many researches dealt with belongings of these alterations and shown the formation of an internal boundary layer. Exchanging shear stresses and the turbulent reply to such a change. Change in land use around Baghdad International Airport through increases urban area may change physical properties of the air above. This study concentrated on effects of change in convective boundary layer (radix layer height) resulted from change in natural surface area determined by observation from remote sensing, satellites images, and radiosonde at nearly 25 years. This will give information on the vertical profile of turbulent that is very benefit to safety management of airport navigation during landing and take-off stages of airplanes. The period of study is in summer season in July where there is large increase in temperature and heating surface to high temperature and most of the heat is stored in building area. This heat released to air to constrict air plumes raised to high level and make turbulent in addition to the turbulent resulted from wind shear and friction.

References

[1] A. K. Mohammed and F. K. M. Al Ramahi, "A study of the Effect of Urbanization on Annual Evaporation Rates in Baghdad City Using Remote Sensing," *Iraqi J. Sci.*, pp. 2142–2149, 2020.

[2] H. Zhang *et al.*, "Research progress on estimation of the atmospheric boundary layer height," *J. Meteorol. Res.*, vol. 34, no. 3, pp. 482–498, 2020.

[3] A. F. Hassoon and A. B. Ali, "Irregular urban Expansion and Its Effects on Air Temperature over Baghdad City using Remote Sensing Technique," *Iraqi J. Sci.*, pp. 2110–2121, 2021.

[4] J. Iribarne and H. Cho, *Atmospheric physics*. Springer Science & Business Media, 2012.

[5] F. Y. Yang, "Comparison of determination methods and characteristics of boundary layer height in semi-arid area.," Master's Thesis , Lanzhou University, 2018.

[6] P. H. Hildebrand and B. Ackerman, "urban effects on the convective boundary layer," *J. Atmos. Sci.*, vol. 41, no. 1, 1983.

[7] A. F. Hassoon, S. K. Mohammed, and H. H. H. Al-Saleem, "Atmospheric Stability and Its Effect on The Polluted Columns of Concentrations in North West of Baghdad City," *Iraqi J. Sci.*, vol. 55, no. 2A, pp. 572–581, 2014.

[8] S. R. Al-Ghrybawi and M. H. Al-Jiboori, "Study of surface heat inversions characteristics around Baghdad station," *Przegląd Nauk. Inżynieria i Kształtowanie Środowiska*, vol. 28, no. 4 [86], 2019.

[9] A. O'Connor and D. Kearney, "Evaluating the effect of turbulence on aircraft during landing and take-off phases," *Int. J. Aviat. Aeronaut. Aerosp.*, vol. 5, no. 4, p. 10, 2018.

[10] Y. Zhao and L. Sushama, "Aircraft Takeoff Performance in a Changing Climate for Canadian Airports," *Atmosphere (Basel).*, vol. 11, no. 4, p. 418, 2020.

[11] R. Sharman and T. Lane, "Aviation Turbulence," *Springer Int. Publ. Switzerland, DOI*, vol. 10, pp. 973–978, 2016.

[12] L. Shuyan and X. Z. Liang, "Observed diurnal cycle climatology of planetary boundary layer height.," *J. Clim.*, vol. 23, pp. 5790–5809, 2010, doi: doi: 10.1023/A:1005510130752.

[13] Q. Li, H. Zhang, T. Ju, and K. Xiao, "Experimental research on the characteristics of the atmospheric boundary layer in the semi-arid North China," *Acta Sci.*, vol. 56, pp. 215–222, 2020, doi: http://dx.doi.org/10.13209/j.0479-8023.2019.125.

[14] H. A. Al-Shamary, "Characteristic of the Boundary layer above the Surface of Baghdad City and Measuring the Mixing Length," M.S. thesis, Dept. of atmospheric sciences Mustansiriyah University , Baghdad - Iraq, 2006.

[15] H. M. M. Al-Hasnawi, "Similarity Equations for Vertical Wind profiles in the Radix Layer above Baghdad City," Mustansiria University, 2009.

[16] N. A. Al-Tai, "Analytical Study of Boundary Layer Depth over Iraq Using European Center for Mediumrange Weather Forecasts Data," M.S. thesis, Dept. of atmospheric sciences Mustansiriyah University , Baghdad - Iraq, 2011.

[17] S. A. Haraj and M. H. Al-Jiboori, "Study of aerodynamic surface roughness for Baghdad city using signal-level measurements," *Baghdad Sci. J.*, vol. 16, no. 1, pp. 215–220, 2019, doi: 10.21123/bsj.2019.16.1(Suppl.).0215.

[18] M. Jarraud, "Guide to meteorological instruments and methods of observation (WMO-No. 8)," Switzerland Geneva, 2008.

[19] R. Stull, *Practical Meteorology An Algebra-based Survey of Atmospheric Science*. Vancouver, Canada: The University of British Columbia, 2016.

[20] A. Kumar, A. C. Pandey, and A. T. Jeyaseelan, "Built-up and vegetation extraction and density mapping using WorldView-II," *Geocarto Int.*, vol. 27, no. 7, pp. 557–568, 2012.

[21] T. R. Oke, "Boundary Layer Climates.–2nd Edition, 435 S." Cambridge (University Press), 1987.

[22] J. Benson, "Boundary-layer response to a change in surface roughness," M.S. thesis, Department of Meteorology,University of Reading, 2005.

[23] Y. Fan, J. C. R. Hunt, and Y. Li, "Buoyancy and turbulence-driven atmospheric circulation over urban areas," *J. Environ. Sci.*, vol. 59, pp. 63–71, 2017.

[24] J. Wallace and P. Hobbs, *Atmospheric Science : an Introductory Survey(Vol. 92)*. Academic Press (Elsevier), 2006.

[25] J. Malcher and H. Krause, "Low - level jet phenomena Described by an Integrated Dynamic PBL model," *Bound. Layer Meteor.*, vol. 27, pp. 327 – 343, 1983.

[26] A. F. Hassoon and M. K. Tawfiq, "DETERMINED ABU-KHOV LENGTH OVER BAGHDAD CITY," *J. Eng. Sustain. Dev.*, vol. 23, no. 03, 2019.

[27] S. Zilitinkevich, "On the Determination of the Height of the Ekman Boundary Layer," *Bound. Layer Meteor*, vol. 3, pp. 141–145, 1972.

[28] E. Santoso and R. Stull, "Similarity Equation for Wind and Temperature Profile in the Radix Layer , at the Bottom of the convective boundary layer," *J. Atmos. Sci.*, vol. 58, pp. 1446 – 1464, 2001.

[29] E. Santoso, "surface fluxes and vertical profiles in the radix layer," Ph.D. Thesis in department of geography, atmospheric science program, Univesity of British Columbia, 1999.