$$\frac{dx}{dt} = \left(\alpha_x \left(k_1 + \frac{(1-k_1)z}{z+k_2} \right) - \beta_x \left(k_3 + \frac{(1-k_3)z}{z+k_4} \right) - m_1 \left(1 - \frac{z}{z_0} \right) \right) x$$

$$\frac{dy}{dt} = m_1 \left(1 - \frac{z}{z_0} \right) x + \left(\alpha_y \left(1 - d \frac{z}{z_0} \right) - \beta_y \right) y$$

$$\frac{dz}{dt} = \frac{z_0 - z}{\tau}$$

$$\frac{dv}{dt} = \left(\alpha_x \left(k_1 + \frac{(1-k_1)z}{z+k_2} \right) - \beta_x \left(k_3 + \frac{(1-k_3)z}{z+k_4} \right) - m_1 \left(1 - \frac{z}{z_0} \right) \right) x$$

$$+ m_1 \left(1 - \frac{z}{z_0} \right) x + \left(\alpha_y \left(1 - d \frac{z}{z_0} \right) - \beta_y \right) y$$